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Header Protection for Cryptographically Protected E-mail
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Abstract

S/MIME version 3.1 introduced a mechanism to provide end-to-end cryptographic protection of e-mail message headers. However, few implementations generate messages using this mechanism, and several legacy implementations have revealed rendering or security issues when handling such a message.

This document updates the S/MIME specification ([RFC8551]) to offer a different mechanism that provides the same cryptographic protections but with fewer downsides when handled by legacy clients. The Header Protection schemes described here are also applicable to messages with PGP/MIME cryptographic protections. Furthermore, this document offers more explicit guidance for clients when generating or handling e-mail messages with cryptographic protection of message headers.

About This Document

This note is to be removed before publishing as an RFC.

The latest revision of this draft can be found at <https://dkg.gitlab.io/lamps-header-protection/>. Status information for this document may be found at <https://datatracker.ietf.org/doc/draft-ietf-lamps-header-protection/>.

Discussion of this document takes place on the LAMPS Working Group mailing list (<mailto:spasm@ietf.org>), which is archived at <https://mailarchive.ietf.org/arch/browse/spasm/>. Subscribe at <https://www.ietf.org/mailman/listinfo/spasm/>.

Source for this draft and an issue tracker can be found at <https://gitlab.com/dkg/lamps-header-protection>.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

Privacy and security issues regarding e-mail Header Protection in S/MIME and PGP/MIME have been identified for some time. Most current implementations of cryptographically-protected electronic mail protect only the body of the message, which leaves significant room for attacks against otherwise-protected messages. For example, lack of Header Protection allows an attacker to substitute the message subject and/or author.

This document describes two different schemes for how message headers can be cryptographically protected, and provides guidance for implementers of MUAs that generate and interpret such messages. It

uses the term "Legacy MUA" to refer to an MUA that does not implement either scheme. This document takes particular care to ensure that messages interact reasonably well with Legacy MUAs.

1.1. Two Schemes of Header Protection

This document addresses two different schemes for cryptographically protecting e-mail Header Sections or fields and provides guidance to implementers. One scheme ("Injected Headers") is more interoperable with Legacy MUAs, and is mandatory to implement and interpret. The other, older scheme ("Wrapped Message") is described here to enable interpretation of archived messages.

The older scheme was first specified in S/MIME 3.1 ([RFC8551]), and involves wrapping a message/rfc822 or message/global MIME object with a Cryptographic Envelope around the message to protect. This document calls this scheme "Wrapped Message", and it updates the scheme described in that document, effectively replacing the final two paragraphs of Section 3.1 of [RFC8551]. However, experience has shown that even the updated "Wrapped Message" form does not interact well with some Legacy MUAs (see Section 1.2).

The more interoperable "Injected Headers" scheme of Header Protection is introduced in this document, and is preferred over the "Wrapped Message" scheme. In the "Injected Headers" scheme, the protected Header Fields are placed directly on the Cryptographic Payload, without using an intervening message/* MIME object. See Section 2.3.4 and Section 2.5.3 for more details.

1.2. Problems with Wrapped Messages

Several Legacy MUAs have revealed rendering issues when dealing with a message that uses the Wrapped Message Header Protection scheme.

In some cases, some mail user agents cannot render message/rfc822 message subparts at all, in violation of baseline MIME requirements as described on page 5 of [RFC2049]. This leaves all Wrapped Messages unreadable by any recipient using such an MUA.

In other cases, the user sees an attachment suggesting a forwarded e-mail message, which -- in fact -- contains the protected e-mail message that should be rendered directly. In most of these cases, the user can click on the attachment to view the protected message.

However, viewing the protected message as an attachment in isolation may strip it of any security indications, leaving the user unable to assess the cryptographic properties of the message. Worse, for encrypted messages, interacting with the protected message in isolation may leak contents of the cleartext, for example, if the reply is not also encrypted.

1.3. Problems with Injected Headers

A Legacy MUA dealing with an encrypted message that has some Header Fields obscured using the Injected Headers scheme will not render the obscured Header Fields to the user at all. A workaround "Legacy Display" mechanism is provided in this document, which most Legacy MUAs should render to the user, albeit not in the same location that the Header Fields would normally be rendered.

1.4. Motivation

Users generally do not understand the distinction between message body and message header. When an e-mail message has cryptographic protections that cover the message body, but not the Header Fields, several attacks become possible.

For example, a Legacy Signed Message has a signature that covers the body but not the Header Fields. An attacker can therefore modify the Header Fields (including the Subject header) without invalidating the signature. Since most readers consider a message body in the context of the message's Subject header, the meaning of the message itself could change drastically (under the attacker's control) while still retaining the same cryptographic indicator of authenticity.

In another example, a Legacy Encrypted Message has its body effectively hidden from an adversary that snoops on the message. But if the Header Fields are not also encrypted, significant information about the message (such as the message Subject) will leak to the inspecting adversary.

However, if the sending and receiving MUAs ensure that cryptographic protections cover the message Header Section as well as the message body, these attacks are defeated.

1.4.1. Backward Compatibility

If the sending MUA is unwilling to generate such a fully-protected message due to the potential for rendering, usability, deliverability, or security issues, these defenses cannot be realized.

The sender cannot know what MUA (or MUAs) the recipient will use to handle the message. Thus, an outbound message format that is backward-compatible with as many legacy implementations as possible is a more effective vehicle for providing the whole-message cryptographic protections described above.

This document aims for backward compatibility with Legacy MUAs to the extent possible. In some cases, like when a user-visible header like the Subject is cryptographically hidden, the message cannot behave entirely identically to a Legacy MUA. But accommodations are described here that ensure a rough semantic equivalence for Legacy MUA even in these cases.

1.4.2. Deliverability

A message with perfect cryptographic protections that cannot be delivered is less useful than a message with imperfect cryptographic protections that can be delivered. Senders want their messages to reach the intended recipients.

Given the current state of the Internet mail ecosystem, encrypted messages in particular cannot shield all of their Header Fields from visibility and still be guaranteed delivery to their intended recipient.

This document accounts for this concern by providing a mechanism (Section 2.3.2) that prioritizes initial deliverability (at the cost of some header leakage) while facilitating future message variants that shield more header metadata from casual inspection.

1.5. Other Protocols to Protect E-Mail Header Fields

A separate pair of protocols also provides some cryptographic protection for the e-mail message header integrity: DomainKeys Identified Mail (DKIM) [RFC6376], as used in combination with Domain-based Message Authentication, Reporting, and Conformance (DMARC) [RFC7489]. This pair of protocols provides a domain-based reputation mechanism that can be used to mitigate some forms of unsolicited e-mail (spam).

However, the DKIM+DMARC suite provides cryptographic protection at a different scope than the mechanisms described here. In particular, the message integrity and authentication signals provided by DKIM+DMARC correspond to the domain name of the sending e-mail address, not the sending address itself, so the DKIM+DMARC suite does not provide end-to-end protection. DKIM and DMARC are typically applied to messages by (and interpreted by) mail transfer agents, not mail user agents. The mechanisms in this document are typically applied to messages by (and interpreted by) mail user agents.

Furthermore, the DKIM+DMARC suite only provides cryptographic integrity and authentication, not encryption. So cryptographic confidentiality is not available from that suite.

The DKIM+DMARC suite can be used on any message, including messages formed as described in this document. There should be no conflict between these schemes.

Though not strictly e-mail, similar protections have been in use on Usenet for signing and verification of message headers for years. See ([PGPCONTROL] and [PGPVERIFY-FORMAT] for more details. Like DKIM, these Usenet control protections offer only integrity and authentication, not encryption.

1.6. Applicability to PGP/MIME

This document describes end-to-end cryptographic protections for e-mail messages in reference to S/MIME ([RFC8551]).

Comparable end-to-end cryptographic protections can also be provided by PGP/MIME ([RFC3156]).

The mechanisms in this document should be applicable in the PGP/MIME protections as well as S/MIME protections, but analysis and implementation in this document focuses on S/MIME.

To the extent that any divergence from the mechanism described here is necessary for PGP/MIME, that divergence is out of scope for this document.

1.7. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

The key words "SPECIFICATION REQUIRED" and "IETF REVIEW" that appear in this document when used to describe namespace allocation are to be interpreted as described in [RFC8126].

1.8. Terms

The following terms are defined for the scope of this document:

- * S/MIME: Secure/Multipurpose Internet Mail Extensions (see [RFC8551])
- * PGP/MIME: MIME Security with OpenPGP (see [RFC3156])
- * Message: An E-Mail Message consisting of Header Fields (collectively called "the Header Section of the message") followed, optionally, by a Body; see [RFC5322].

Note: To avoid ambiguity, this document avoids using the terms "Header" or "Headers" in isolation, but instead always uses "Header Field" to refer to the individual field and "Header Section" to refer to the entire collection.

- * Header Field: A Header Field includes a field name, followed by a colon (":"), followed by a field body (value), and terminated by CRLF; see Section 2.2 of [RFC5322] for more details.
- * Header Section: The Header Section is a sequence of lines of characters with special syntax as defined in [RFC5322]. The Header Section of a Message contains the Header Fields associated with the Message itself. The Header Section of a MIME part (that is, a subpart of a message) typically contains Header Fields associated with that particular MIME part.
- * Body: The Body is the part of a Message that follows the Header Section and is separated from the Header Section by an empty line (i.e., a line with nothing preceding the CRLF); see [RFC5322]. It is the (bottom) section of Message containing the payload of a Message. Typically, the Body consists of a (possibly multipart) MIME [RFC2045] construct.
- * Header Protection (HP): cryptographic protection of e-mail Header Sections (or parts of it) for signatures and/or encryption
- * Cryptographic Layer, Cryptographic Payload, Cryptographic Envelope, Cryptographic Summary, Structural Header Fields, Main Body Part, User-Facing Header Fields, and MUA are all used as defined in [I-D.ietf-lamps-e2e-mail-guidance]

- * **Legacy MUA:** an MUA that does not understand Header Protection as described in this document. A Legacy Non-Crypto MUA is incapable of doing any end-to-end cryptographic operations. A Legacy Crypto MUA is capable of doing cryptographic operations, but does not understand or generate messages with Header Protection.
- * **Legacy Signed Message:** an e-mail message that was signed by a Legacy MUA (and therefore has no cryptographic authenticity or integrity protections on its Header Fields).
- * **Wrapped Message:** The Header Protection scheme that uses the mechanism described in [RFC8551], where the Cryptographic Payload is a message/rfc822 or message/global MIME object, augmented with a Content-Type parameter to indicate that this is the explicit intent. (see Section 2.2).
- * **Injected Headers:** The Header Protection scheme that uses the mechanism described in this document (see Section 2.1), where the protected Header Fields are inserted on the Cryptographic Payload directly.
- * **Header Confidentiality Policy (HCP):** a functional specification of which Header Fields should be obscured when composing an encrypted message with Header Protection. See Section 2.3.2.
- * **Ordinary User:** a user of an MUA who follows a simple and minimal experience, focused on sending and receiving e-mails. A user who opts into advanced configuration, expert mode, or the like is not an "Ordinary User".

1.9. Document Scope

This document describes sensible, simple behavior for a program that generates an e-mail message with standard end-to-end cryptographic protections, following the guidance in [I-D.ietf-lamps-e2e-mail-guidance]. An implementation conformant to this draft will produce messages that have cryptographic protection that covers the message's Header Fields as well as its body.

1.9.1. In Scope

This document also describes sensible, simple behavior for a program that interprets such a message, in a way that can take advantage of these protections covering the Header Fields as well as the body.

The message generation guidance aims to minimize negative interactions with any Legacy receiving MUA while providing actionable cryptographic properties for modern receiving clients.

In particular, this document focuses on two standard types of cryptographic protection that cover the entire message:

- * A cleartext message with a single signature, and
- * An encrypted message that contains a single cryptographic signature.

1.9.2. Out of Scope

The message composition guidance in this document (in Section 2.3.4) aims to provide minimal disruption for any Legacy MUA that receives such a message. However, a Legacy MUA by definition does not implement any of the guidance here. Therefore, the document does not attempt to provide guidance for Legacy MUAs directly.

Furthermore, this document does not explicitly contemplate other variants of cryptographic message protections, including any of these:

- * Encrypted-only message (without a cryptographic signature)
- * Triple-wrapped message
- * Signed message with multiple signatures
- * Encrypted message with a cryptographic signature outside the encryption.

All such messages are out of scope of this document.

2. Specification

As mentioned in Section 1.1, this document describes two ways to provide end-to-end cryptographic protection for an e-mail message that includes all Header Fields known to the sender at message composition time.

A receiving MUA MUST be able to handle both Header Protection schemes, as described in Section 2.5.

A sending MUA MUST be able to generate the Injected Headers scheme (Section 2.3.4), and MAY generate the Wrapped Message scheme (Section 2.3.5).

2.1. Injected Headers Scheme

A message that uses the Injected Headers scheme has protected Header Fields in the Header Section of the Cryptographic Payload.

For an encrypted message that has at least one user-visible Header Field omitted or obscured outside of the Cryptographic Payload, those Header Fields MAY also be duplicated into decorative copies in the Main Body MIME part of the Cryptographic Payload itself. These decorative copies within the message are known as "Legacy Display Elements".

Such a Legacy Display Element can be useful for a Legacy receiving MUA that doesn't yet understand how to interpret or display a cryptographically-protected confidential header. See Section 3.1 for more details about how the ecosystem could shift so that a sending MUA could avoid the need to generate any Legacy Display Element.

Composing a message with the Injected Headers scheme is described in Section 2.3.4. Rendering such a message is described in Section 2.5.3.

2.2. Wrapped Message Scheme

A message that uses the Wrapped Message scheme has a Cryptographic Payload of a single message/rfc822 (or message/global) MIME object, which itself contains the original message (including the protected Header Section).

The Wrapped Message Header Protection scheme is very similar to that described in Section 3.1 of [RFC8551]. The main augmentations this document provides to that scheme are:

- * an explicit discussion of how to obscure or remove Header Fields,
- * an additional protected-headers=wrapped parameter to the Content-Type Header Field of the Cryptographic Payload to indicate the explicit intent, and
- * a recommendation to mark such a Wrapped Message as Content-Disposition: inline to encourage Legacy MUAs to render the inner message directly rather than treating it as an attachment.

Composing a message with the Wrapped Message scheme is described in Section 2.3.5. Rendering such a message is described in Section 2.5.4.

2.3. Sending Side

This section describes the process an MUA should use to apply cryptographic protection to an e-mail message with Header Protection. We start by describing the legacy message composition process as a baseline.

2.3.1. Composing a Cryptographically-Protected Message Without Header Protection

Section 5.1 of [I-D.ietf-lamps-e2e-mail-guidance] describes the typical process for a Legacy Crypto MUA to apply cryptographic protections to an e-mail message. That guidance and terminology is replicated here for reference:

- * **origbody**: the traditional unprotected message body as a well-formed MIME tree (possibly just a single MIME leaf part). As a well-formed MIME tree, origbody already has structural Header Fields (Content-*) present.
- * **origheaders**: the intended non-structural Header Fields for the message, represented here as a list of (h,v) pairs, where h is a Header Field name and v is the associated value. Note that these are Header Fields that the MUA intends to be visible to the recipient of the message. In particular, if the MUA uses the Bcc header during composition, but plans to omit it from the message (see Section 3.6.3 of [RFC5322]), it will not be in origheaders.
- * **crypto**: The series of cryptographic protections to apply (for example, "sign with the secret key corresponding to X.509 certificate X, then encrypt to X.509 certificates X and Y"). This is a routine that accepts a MIME tree as input (the Cryptographic Payload), wraps the input in the appropriate Cryptographic Envelope, and returns the resultant MIME tree as output.

The algorithm returns a MIME object that is ready to be injected into the mail system:

- * Apply crypto to MIME part origbody, producing MIME tree output
- * For each Header Field name and value (h,v) in origheaders:
 - Add Header Field h to output with value v
- * Return output

2.3.2. Header Confidentiality Policy

When composing an encrypted message with Header Protection, the composing MUA needs a Header Confidentiality Policy (HCP). In this document, we represent that Header Confidentiality Policy as a function `hcp`:

```
* hcp(name, val_in) val_out: this function takes a non-structural
  Header Field identified by name with initial value val_in as
  arguments, and returns a replacement header value val_out. If
  val_out is the special value null, it means that the Header Field
  in question should be omitted from the set of Header Fields
  visible outside the Cryptographic Envelope.
```

Note that `hcp` is only applied to non-structural Header Fields. When composing a message, Structural Header Fields are dealt with separately, as described in Section 2.3.4 and Section 2.3.5.

As an example, an MUA that obscures the Subject Header Field by replacing it with the literal string "[...]", hides all Cc'ed recipients, and does not offer confidentiality to any other Header Fields would be represented as (in pseudocode):

```
hcp_hide_cc(name, val_in) val_out:
  if name is 'Subject':
    return '['...']'
  else if name is 'Cc':
    return null
  else:
    return val_in
```

Note that such a policy is only needed when the end-to-end protections include encryption (confidentiality). No comparable policy is needed for other end-to-end cryptographic protections (integrity and authenticity), as they are simply uniformly applied so that all Header Fields known by the sender have these protections.

This asymmetry is an unfortunate consequence of complexities in message delivery systems, some of which may reject, drop, or delay messages where all Header Fields are removed from the top-level MIME object.

This document does not mandate any particular Header Confidentiality Policy, though it offers guidance for MUA implementers in selecting one in Section 2.4. Future documents may recommend or mandate such a policy for an MUA with specific needs. Such a recommendation might be motivated by descriptions of metadata-derived attacks, or stem from research about message deliverability, or describe new signalling mechanisms, but these topics are out of scope for this document.

For alignment with common practice as well as the ABNF in Section 2.3.3 for HP-Obscured, val_out MUST be one of the following:

- * identical to val_in, or
- * the special value null, or
- * a sequence of printable and whitespace (that is, space or tab) 7-bit clean US-ASCII characters (of course, non-ASCII text can be encoded as US-ASCII using the encoded-word construct from [RFC2047])

The HCP can compute val_out using any technique describable in pseudocode, such as copying a fixed string or invocations of other pseudocode functions. If it alters the value, it MUST NOT include control or NUL characters in val_out.

2.3.3. Definition of HP-Removed and HP-Obscured Header Fields

This document defines 2 new Header Fields used for conveying the effect of sender's Header Confidentiality Policy: HP-Removed and HP-Obscured. These Header Fields enable the MUA receiving an encrypted message to reliably identify whether the sending MUA intended to make a Header Field confidential (see Section 6.2.3).

An implementation that composes encrypted e-mail and hides any of the Header Fields as described in this document (for example, due to a non-null HCP) MUST include the appropriate HP-Removed or HP-Obscured Header Fields in the Cryptographic Payload. These two MIME Header Fields should only ever appear directly within the Header Section of the Cryptographic Payload of a Cryptographic Envelope offering confidentiality. They MUST be ignored if they appear in other places.

HP-Removed includes a comma separated list of Header Field names that were omitted from the outer header when the message with Header Protection was generated. The HP-Removed Header Field can appear at most once in the Header Section of a Cryptographic Payload.

Each instance of HP-Obscured contains a Header Field name and the value that this Header Field was modified to in the outer header. The HP-Obscured Header Field can appear multiple times in the Header Section of a Cryptographic Payload.

If a Header Field name A doesn't appear in an HP-Obscured Header Field value, then the Header Field A was either removed (and thus would appear in the HP-Removed Header Field) or it was copied without any modifications to the outer header.

Syntax of these new Header Fields is defined using the following ABNF [RFC5234], where field-name, WSP, VCHAR, and FWS are defined in [RFC5322]:

```
hp-removed      = "HP-Removed:" field-name-list CRLF
field-name-list = [FWS] field-name
                  *([FWS] "," [FWS] field-name) [FWS]

hp-obscured     = "HP-Obscured:" [FWS] field-name ":" "
                  replacement-value CRLF

replacement-value = (*([FWS] VCHAR) *WSP)
```

Note that replacement-value is the same as unstructured from [RFC5322], but without the obsolete obs-unstructured option.

2.3.4. Composing with "Injected Headers" Header Protection

The "Injected Headers" Header Protection scheme places the Header Fields to be protected directly on the Cryptographic Payload. Unlike in the "Wrapped Scheme" (see compose-wrapped-message), there is no wrapping of the message body in any additional message/* MIME part. This section describes how to generate such a message.

To compose a message using "Injected Headers" Header Protection, the composing MUA uses the following inputs:

- * All the inputs described in Section 2.3.1
- * hcp: a Header Confidentiality Policy, as defined in Section 2.3.2
- * legacy: a boolean value, indicating whether any recipient of the message is believed to have a Legacy MUA. If all recipients are known to implement this draft, legacy should be set to false. (How an MUA determines the value of legacy is out of scope for this document; an initial implementation can simply set it to true)

Enabling visibility of obscured Header Fields for decryption-capable legacy clients requires transforming a header list into a readable form and including it as a decorative Legacy Display Element in specially-marked parts of the message. This document recommends two different mechanisms for such a decorative adjustment: one for a text/html Main Body Part of the e-mail message, and one for a text/plain Main Body Part. This document does not recommend adding a Legacy Display Element to any other part.

Please see Section 7.1 of [I-D.ietf-lamps-e2e-mail-guidance] for guidance on identifying the parts of a message that are a Main Body Part.

To build such a message, we replace the algorithm described in Section 2.3.1 with a more sophisticated approach. The algorithm for applying "Injected Headers" cryptographic protection to a message is as follows:

- * Let newbody be a copy of origbody
- * If crypto contains encryption, and legacy is true:
 - Create ldlist, an empty list of (header, value) pairs
 - For each Header Field name and value (h,v) in origheaders:
 - o If h is user-facing (see Section 1.1.2 of [I-D.ietf-lamps-e2e-mail-guidance]):
 - + If hcp(h,v) is not v:
 - * Add (h,v) to ldlist
 - If ldlist is not empty:
 - o Identify each leaf MIME part of newbody that represents the "main body" of the message.
 - o For each "Main Body Part" bodypart of type text/plain or text/html:
 - + Adjust bodypart by inserting a Legacy Display Element header list ldlist into its content, and adding a Content-Type parameter hp-legacy-display with value 1 (see Section 2.3.4.1 for text/plain and Section 2.3.4.2 for text/html)
- * For each Header Field name and value (h,v) in origheaders:

- Add Header Field *h* to MIME part *newbody* with value *v*
- * Set the *protected-headers* parameter on the Content-Type of MIME part *newbody* to *v1*
- * If *crypto* does not contain encryption:
 - Let *newheaders* be a copy of *origheaders*
- * Else (if *crypto* contains encryption):
 - Create new empty list of Header Field names and values *newheaders*
 - Let *hpr* be an empty comma-separated list of Header Field names
 - For each Header Field name and value (*h,v*) in *origheaders*:
 - o Let *newval* be *hcp(h,v)*
 - o If *newval* is null:
 - + Add the value *h* to *hpr*
 - o Else (if *newval* is not null):
 - + Add (*h,newval*) to *newheaders*
 - + If *newval* is not *v*:
 - * Let string *record* be the concatenation of *h*, a literal *": "* (ASCII colon (0x3A) followed by ASCII space (0x20)), and *newval*
 - * Add Header Field "HP-Obscured" to MIME part *newbody* with value *record*
 - If *hpr* is not empty:
 - o Add Header Field "HP-Removed" to MIME part *newbody* with value *hpr*
 - * Apply *crypto* to MIME part *newbody*, producing MIME tree output
 - * For each Header Field name and value (*h,v*) in *newheaders*:
 - Add Header Field *h* to output with value *v*

* Return output

Note that both new parameters (hcp and legacy) are effectively ignored if crypto does not contain encryption. This is by design, because they are irrelevant for signed-only cryptographic protections.

2.3.4.1. Adding a Legacy Display Element to a text/plain Part

For a list of obscured Header Fields represented as (header, value) pairs, concatenate them as a set of lines, with one newline at the end of each pair. Add an additional trailing newline after the resultant text, and prepend the entire list to the body of the text/plain part.

The MUA MUST also add a Content-Type parameter of hp-legacy-display with value 1 to the MIME part to indicate that a Legacy Display Element was added.

For example, if the list of obscured Header Fields was [("Cc", "alice@example.net"), ("Subject", "Thursday's meeting")], then a text/plain Main Body Part that originally looked like this:

Content-Type: text/plain; charset=UTF-8

I think we should skip the meeting.

Would become:

Content-Type: text/plain; charset=UTF-8; hp-legacy-display=1

Subject: Thursday's meeting
Cc: alice@example.net

I think we should skip the meeting.

Note that the Legacy Display Element (the lines beginning with Subject: and Cc:) are part of the body of the MIME part in question.

This example assumes that the Main Body Part in question is not the root of the Cryptographic Payload. For instance, it could be a leaf of a multipart/alternative Cryptographic Payload. This is why no additional Header Fields have been injected into the MIME part in this example.

2.3.4.2. Adding a Legacy Display Element to a text/html Part

Adding a Legacy Display Element to a text/html part is similar to how it is added to a text/plain part (see Section 2.3.4.1). Instead of adding the obscured or removed User-Facing Header Fields to a block of text delimited by a blank line, the composing MUA injects them in an HTML <div> element annotated with a class attribute of header-protection-legacy-display.

The content and formatting of this decorative <div> have no strict requirements, but they MUST represent all the obscured and removed User-Facing Header Fields in a readable fashion. A simple approach is to assemble the text in the same way as Section 2.3.4.1, wrap it in a verbatim <pre> element, and put that element in the annotated <div>.

The annotated <div> should be placed as close to the start of the <body> as possible, where it will be visible when viewed with a standard HTML renderer.

The MUA MUST also add a Content-Type parameter of hp-legacy-display with value 1 to the MIME part to indicate that a Legacy Display Element was added.

For example, if the list of obscured Header Fields was [("Cc", "alice@example.net"), ("Subject", "Thursday's meeting")], then a text/html Main Body Part that originally looked like this:

Content-Type: text/html; charset=UTF-8

```
<html><head><title></title></head><body>
<p>I think we should skip the meeting.</p>
</body></html>
```

Would become:

Content-Type: text/html; charset=UTF-8; hp-legacy-display=1

```
<html><head><title></title></head><body>
<div class="header-protection-legacy-display">
<pre>Subject: Thursday's meeting
Cc: alice@example.net</pre></div>
<p>I think we should skip the meeting.</p>
</body></html>
```

This example assumes that the Main Body Part in question is not the root of the Cryptographic Payload. For instance, it could be a leaf of a multipart/alternative Cryptographic Payload. This is why no additional Header Fields have been injected into the MIME part in this example.

2.3.4.2.1. Step-by-step Example for Inserting Legacy Display Element to text/html

A composing MUA MAY insert the Legacy Display Element anywhere reasonable within the message as long as it prioritizes visibility for the reader using a Legacy decryption-capable MUA. This decision may take into account special message-specific HTML formatting expectations if the MUA is aware of them. However, some MUAs may not have any special insight into the user's preferred HTML formatting, and still want to insert a Legacy Display Element. This section offers a non-normative, simple, and minimal step-by-step approach for a composing MUA that has no other information or preferences to fall back on.

The process below assumes that the MUA already has the full HTML object that it intends to send, including all of the text supplied by the user.

- * Assemble the text exactly as specified for text/plain (see Section 2.3.4.1).
- * Wrap that text in a verbatim `<pre>` element.
- * Wrap that `<pre>` element in a `<div>` element annotated with the class header-protection-legacy-display.
- * Find the `<body>` element of the full HTML object.
- * Insert the `<div>` element as the first child of the `<body>` element.

2.3.4.3. Only Add a Legacy Display Element to Main Body Parts

Some messages may contain a text/plain or text/html subpart that is not a Main Body Part. For example, an e-mail message might contain an attached text file or a downloaded webpage. Attached documents need to be preserved as intended in the transmission, without modification.

The composing MUA MUST NOT add a Legacy Display Element to any part of the message that is not a Main Body Part. In particular, if a part is annotated with Content-Disposition: attachment, or if it does not descend via the first child of any of its multipart/mixed or multipart/related ancestors, it is not a Main Body Part, and MUST NOT be modified.

See Section 7.1 of [I-D.ietf-lamps-e2e-mail-guidance] for more guidance about common ways to distinguish Main Body Parts from other MIME parts in a message.

2.3.4.4. Do Not Add a Legacy Display Element to Other Content-Types

The purpose of injecting a Legacy Display Element into each Main Body MIME part is to enable rendering of otherwise obscured Header Fields in Legacy MUAs that are capable of message decryption, but don't know how to follow the rest of the guidance in this document.

The authors are unaware of any Legacy MUA that would render any MIME part type other than text/plain and text/html as the Main Body. A generating MUA SHOULD NOT add a Legacy Display Element to any MIME part with any other Content-Type.

2.3.5. Composing with "Wrapped Message" Header Protection

The Wrapped Message Header Protection scheme is very similar to that described in Section 3.1 of [RFC8551]. The differences are outlined in Section 2.2.

To compose a message using "Wrapped Message" Header Protection, the composing MUA uses the following inputs:

- * All the inputs described in Section 2.3.1
- * hcp: a Header Confidentiality Policy, as defined in Section 2.3.2

To build such a message, we replace the algorithm described in Section 2.3.1 with a more sophisticated approach. The algorithm for applying "Wrapped Message" cryptographic protection to a message is as follows:

- * Let newbody be a copy of origbody
- * For each Header Field name and value (h,v) in origheaders:
 - Add Header Field h to MIME part newbody with value v
- * If crypto does not contain encryption:

- Let newheaders be a copy of origheaders
- * Else (if crypto contains encryption):
 - Create new empty list of Header Field names and values newheaders
 - Let hpr be an empty comma-separated list of Header Field names
 - For each Header Field name and value (h,v) in origheaders:
 - o Let newval be hcp(h,v)
 - o If newval is null:
 - + Add the value h to hpr
 - o Else (if newval is not null):
 - + Add (h,newval) to newheaders
 - + If newval is not v:
 - * Let string record be the concatenation of h, a literal ":", " (ASCII colon (0x3A) followed by ASCII space (0x20)), and newval
 - * Add Header Field "HP-Obscured" to MIME part newbody with value record
 - If hpr is not empty:
 - o Add Header Field "HP-Removed" to MIME part newbody with value hpr
- * If any of the Header Fields in MIME part newbody, including Header Fields in the nested internal MIME structure, contain any 8-bit UTF-8 characters (see Section 3.7 of [RFC6532]):
 - Let payload be a new MIME part with one Header Field: Content-Type: message/global; protected-headers=wrapped, and whose body is newbody.
- * Else:
 - Let payload be a new MIME part with one Header Field: Content-Type: message/rfc822; protected-headers=wrapped, and whose body is newbody.

- * Add a Content-Disposition Header Field to MIME part payload with value inline
- * Apply crypto to MIME part payload, producing MIME tree output
- * For each Header Field name and value (h,v) in newheaders:
 - Add Header Field h to output with value v
- * Return output

Note that the Header Confidentiality Policy hcp parameter is effectively ignored if crypto does not contain encryption. This is by design, because it is irrelevant for signed-only cryptographic protections.

2.3.6. Choosing Between Wrapped Message and Injected Headers

When composing a message with end-to-end cryptographic protections, an MUA SHOULD protect the Header Fields of that message as well as the body, using one of the formats described here.

A compatible MUA MUST be capable of generating a message with Header Protection using the Injected Headers Section 2.3.4 format.

2.4. Default Header Confidentiality Policy

An MUA MUST have a default Header Confidentiality Policy that offers at least the protections provided by hcp_minimal as described in Section 2.4.1. Local policy and configuration may alter this default, but the MUA SHOULD NOT require the user to select an HCP.

hcp_minimal provides confidentiality for the Subject Header Field by replacing it with the literal string "[...]". This is a sensible minimal default because most users treat the Subject of a message the same way that they treat the body, and they are surprised to find that the Subject of an encrypted message is visible.

2.4.1. Minimal Header Confidentiality Policy

The most conservative recommended Header Confidentiality Policy only protects the Subject Header Field:

```
hcp_minimal(name, val_in)  val_out:
    if name is 'Subject':
        return '[...]'
    else:
        return val_in
```

hcp_minimal is the recommended default HCP for a new implementation, as it provides meaningful confidentiality protections, and is unlikely to cause deliverability or usability problems.

2.4.2. Strong Header Confidentiality Policy

Alternately, a more aggressive (and therefore more privacy-preserving) Header Confidentiality Policy only leaks a handful of fields whose absence is known to increase rates of delivery failure, and simultaneously obscures the Message-ID behind a random new one:

```
hcp_strong(name, val_in)  val_out:
    if name in ['From', 'To', 'Cc', 'Date']:
        return val_in
    else if name is 'Subject':
        return ' [...]'
    else if name is 'Message-ID':
        return generate_new_message_id()
    else:
        return null
```

The function generate_new_message_id() represents whatever process the MUA typically uses to generate a Message-ID for a new outbound message.

hcp_strong is known to cause usability problems with message threading for many Legacy MUAs, and is not recommended as a default HCP for new implementations.

2.4.3. Null Header Confidentiality Policy

Legacy MUAs can be conceptualized as offering a null Header Confidentiality Policy, which offers no confidentiality protection to any Header Field:

```
hcp_null(name, val_in)  val_out:
    return val_in
```

A conformant MUA that is not modified by local policy or configuration MUST NOT use hcp_null by default.

2.4.4. Offering Stronger Header Confidentiality

An MUA MAY offer even stronger confidentiality for Header Fields of an encrypted message than described in Section 2.4.2. For example, it might implement an HCP that obfuscates the From field, or omits the Cc field, or ensures Date is represented in UTC (obscuring the local timezone).

The authors of this document hope that implementers with deployment experience will document their chosen Header Confidentiality Policy and the rationale behind their choice.

This document defines `hcp_null`, `hcp_minimal`, `hcp_hide_cc`, and `hcp_strong` as a way to compare and contrast different possible behavioral choices for a composing MUA. While the HCP is not strictly a protocol element, this document creates a registry of named Header Confidentiality Policies for ease of communication.

2.4.4.1. Expert Guidance for Registering Header Confidentiality Policies

There is no formal syntax specified for the Header Confidentiality Policy, but any attempt to specify an HCP for inclusion in the registry needs to provide:

- * a stable reference document clearly indicating the distinct name for the proposed HCP
- * pseudocode that other implementers can clearly and unambiguously interpret
- * a clear explanation of why this HCP is different from all other registered HCPs
- * any relevant considerations related to deployment of the HCP (for example, known or expected deliverability, rendering, or privacy challenges and possible mitigations)

An entry should not be marked as "Recommended" unless it has been shown to offer confidentiality or privacy improvements over the status quo and have minimal or mitigatable negative impact on messages to which it is applied, considering factors such as message deliverability and security. Only one entry in the table (`hcp_minimal`) is initially marked as "Recommended". In the future, more than one entry may be marked as "Recommended".

2.5. Receiving Side

An MUA that receives a cryptographically-protected e-mail will render it for the user.

The receiving MUA will render the message body, a selected subset of Header Fields, and (as described in Section 3 of [I-D.ietf-lamps-e2e-mail-guidance]) provide a summary of the cryptographic properties of the message.

Most MUAs only render a subset of Header Fields by default. For example, few MUAs typically render Message-Id or Received Header Fields for the user, but most do render From, To, Cc, Date, and Subject.

An MUA that knows how to handle a message with Header Protection makes the following two changes to its behavior when rendering a message:

- * If it detects that an incoming message had protected Header Fields, it renders Header Fields for the message from the protected Header Fields, ignoring the external (unprotected) Header Fields.
- * It includes information in the message's Cryptographic Summary to indicate the types of protection that applied to each rendered Header Field (if any).

An MUA that handles a message with Header Protection does not need to render any new Header Fields that it did not render before.

2.5.1. Identifying that a Message has Header Protection

An incoming message can be identified as having Header Protection based on one of two signals:

- * The Cryptographic Payload has Content-Type: message/rfc822 or Content-Type: message/global and the parameter protected-headers has a value of wrapped. See Section 2.5.4 for rendering guidance.
- * The Cryptographic Payload has some other Content-Type and it has parameter protected-headers set to v1. See Section 2.5.3 for rendering guidance.

Messages of both types exist in the wild, and a compliant MUA MUST be able to handle them both. They provide the same semantics and the same meaning.

2.5.2. Updating the Cryptographic Summary

Regardless of whether a cryptographically-protected message has protected Header Fields, the Cryptographic Summary of the message should be modified to indicate what protections the Header Fields have. This field-by-field status is complex and isn't necessarily intended to be presented in full to the user. Rather, it represents the state of the message internally within the MUA, and may be used to influence behavior like replying to the message (see Section 2.5.8.1).

Each Header Field individually has exactly one the following protections:

- * unprotected (this is the case for all Header Fields in messages that have no Header Protection)
- * signed-only (bound into the same validated signature as the enclosing message, but also visible in transit)
- * encrypted-only (only appears within the Cryptographic Payload; the corresponding external Header Field was either omitted or obfuscated)
- * signed-and-encrypted (same as encrypted-only, but additionally is under a validated signature)

Note that while the message itself may be signed-and-encrypted, some Header Fields may be replicated on the outside of the message (e.g. Date). Those Header Fields would be signed-only, despite the message itself being signed-and-encrypted. Additionally, the data from some encrypted or signed-and-encrypted Header Fields may not be fully private (see Section 6.1 for more details).

Rendering the cryptographic status of each Header Field is likely to be complex and messy --- users may not understand it. It is beyond the scope of this document to suggest any specific graphical affordances or user experience. Future work should include examples of successful rendering of this information.

2.5.3. Rendering a Message with Injected Headers

When the Cryptographic Payload does not have a Content-Type of message/rfc822 or message/global, and the parameter protected-headers is set to v1, the values of the protected Header Fields are drawn from the Header Fields of the Cryptographic Payload, and the body that is rendered is the Cryptographic Payload itself.

2.5.3.1. Example Signed-only Message with Injected Headers

```
A application/pkcs7-mime; smime-type="signed-data"
   (unwraps to)
B multipart/alternative [Cryptographic Payload + Rendered Body]
C  text/plain
D  text/html
```

The message body should be rendered the same way as this message:

B multipart/alternative
C text/plain
D text/html

It should render Header Fields taken from part B.

Its Cryptographic Summary should indicate that the message was signed and all rendered Header Fields were included in the signature.

The MUA should ignore Header Fields from part A for the purposes of rendering.

Because this message is signed-only, none of its parts will have a Legacy Display Element.

2.5.3.2. Example Signed-and-Encrypted Message with Injected Headers

Consider a message with this structure, where the MUA is able to validate the cryptographic signature:

E application/pkcs7-mime; smime-type="enveloped-data"
 (decrypts to)
F application/pkcs7-mime; smime-type="signed-data"
 (unwraps to)
G multipart/alternative [Cryptographic Payload + Rendered Body]
H text/plain
I text/html

The message body should be rendered the same way as this message:

G multipart/alternative
H text/plain
I text/html

It should render Header Fields taken from part G.

Its Cryptographic Summary should indicate that the message was signed and encrypted. Each rendered Header Field found in G should be considered against any HP-Removed Header Field found in G and all HP-Obscured Header Fields found in G. If the field's name is found in the list of Header Field names in HP-Removed, or if one of the HP-Obscured fields refers to the field name, then the Header Field should be marked as signed-and-encrypted. Otherwise, the Header Field should be marked as signed-only.

If any of the User-Facing Header Fields are removed or obscured, the composer of this message MAY place Legacy Display Elements in parts H and I.

The MUA should ignore Header Fields from part E for the purposes of rendering.

2.5.3.3. Do Not Render Legacy Display Elements

As described in Section 2.1, a message with cryptographic confidentiality protection MAY include Legacy Display Elements for backward-compatibility with Legacy MUAs. These Legacy Display Elements are strictly decorative, unambiguously identifiable, and will be discarded by compliant implementations.

The receiving MUA SHOULD avoid rendering the identified Legacy Display Elements to the user at all, since it is aware of Header Protection and can render the actual protected Header Fields.

If a text/html or text/plain part within the Cryptographic Envelope is identified as containing Legacy Display Elements, those elements SHOULD be hidden when rendering and SHOULD be dropped when generating a draft reply or inline forwarded message. Whenever a Message or MIME subtree is exported, downloaded or otherwise further processed, implementers should consider whether or not to drop the Legacy Display Elements.

2.5.3.3.1. Identifying a Part with Legacy Display Elements

A receiving MUA acting on a message that contains an encrypting Cryptographic Layer identifies a MIME subpart within the Cryptographic Payload as containing Legacy Display Elements based on the Content-Type of the subpart.

- * The subpart's Content-Type contains a parameter hp-legacy-display with value set to 1
- * The subpart's Content-Type is either text/html (see Section 2.5.3.3.3) or text/plain (see Section 2.5.3.3.2)

Note that the term "subpart" above is used in the general sense: if the Cryptographic Payload is a single part, that part itself may contain a Legacy Display Element if it is marked with the hp-legacy-display=1 parameter.

2.5.3.3.2. Omitting Legacy Display Elements from text/plain

If a text/plain part within the Cryptographic Payload has the Content-Type parameter hp-legacy-display="1", it should be processed before rendering in the following fashion:

- * Discard the leading lines of the body of the part up to and including the first entirely blank line.

Note that implementing this strategy is dependent on the charset used by the MIME part.

See Appendix D.1 for an example.

2.5.3.3.3. Omitting Legacy Display Elements from text/html

If a text/html part within the Cryptographic Payload has the Content-Type parameter `hp-legacy-display="1"`, it should be processed before rendering in the following fashion:

- * If any element of the HTML `<body>` is a `<div>` with class attribute `header-protection-legacy-display`, that entire element should be omitted.

This cleanup could be done, for example, as a custom rule in the MUA's HTML sanitizer, if one exists. Another implementation strategy for an HTML-capable MUA would be to add an entry to the [CSS] stylesheet for such a part:

```
body div.header-protection-legacy-display { display: none; }
```

2.5.4. Rendering a Wrapped Message

Some MUAs may compose and send a message with end-to-end cryptographic protections that offer Header Protection using the Wrapped Message scheme described in Section 3.1 of [RFC8551] as augmented by this document. This section describes how a receiving MUA should identify and render such a message.

When the Cryptographic Payload has Content-Type of `message/rfc822` or `message/global`, and the parameter `protected-headers` is set to `wrapped`, the values of the protected Header Fields are drawn from the Header Fields of the Cryptographic Payload, and the body that is rendered is the body of the Cryptographic Payload.

2.5.4.1. Example Signed-Only Wrapped Message

Consider a message with this structure, where the MUA is able to validate the cryptographic signature:

```
J application/pkcs7-mime; smime-type="signed-data"
   (unwraps to)
K message/rfc822 [Cryptographic Payload]
L multipart/alternative [Rendered Body]
M text/plain
N text/html
```

The message body should be rendered the same way as this message:

```
L multipart/alternative
M text/plain
N text/html
```

It should render Header Fields taken from part K.

Its Cryptographic Summary should indicate that the message was signed and all rendered Header Fields were included in the signature.

The MUA SHOULD ignore Header Fields from part J for the purposes of rendering, unless it is rendering debugging information.

2.5.4.2. Example Signed-and-Encrypted Wrapped Message

Consider a message with this structure, where the MUA is able to validate the cryptographic signature:

```
O application/pkcs7-mime; smime-type="enveloped-data"
   (decrypts to)
P application/pkcs7-mime; smime-type="signed-data"
   (unwraps to)
Q message/rfc822 [Cryptographic Payload]
R multipart/alternative [Rendered Body]
S text/plain
T text/html
```

The message body should be rendered the same way as this message:

```
R multipart/alternative
S text/plain
T text/html
```

It should render Header Fields taken from part Q.

Its Cryptographic Summary should indicate that the message was signed and encrypted. As in Section 2.5.3.2, each rendered Header Field found in Q should be considered against any HP-Removed Header Field found in Q and all HP-Obscured Header Fields found in Q. If the field's name is found in the list of Header Field names in HP-

Removed, or if one of the HP-Obscured fields refers to the field name, then the Header Field should be marked as signed-and-encrypted. Otherwise, the Header Field should be marked as signed-only.

2.5.5. Guidance for Automated Message Handling

Some automated systems have a control channel that is operated by e-mail. For example, an incoming e-mail message could subscribe someone to a mailing list, initiate the purchase of a specific product, approve another message for redistribution, or adjust the state of some shared object.

To the extent that such a system depends on end-to-end cryptographic guarantees about the e-mail control message, Header Protection as described in this document should improve the system's security. This section provides some specific guidance for systems that use e-mail messages as a control channel that want to benefit from these security improvements.

2.5.5.1. Interpret Only Protected Header Fields

Consider the situation where an e-mail-based control channel depends on the message's cryptographic signature and the action taken depends on some Header Field of the message.

In this case, the automated system **MUST** rely on information from the Header Field that is protected by the mechanism described in this document. It **MUST NOT** rely on any Header Field found outside the Cryptographic Payload.

For example, consider an administrative interface for a mailing list manager that only accepts control messages that are signed by one of its administrators. When an inbound message for the list arrives, it is queued (waiting for administrative approval) and the system generates and listens for two distinct e-mail addresses related to the queued message -- one that approves the message, and one that rejects it. If an administrator sends a signed control message to the approval address, the mailing list verifies that the protected To: Header Field of the signed control message contains the approval address before approving the queued message for redistribution. If the protected To: Header Field does not contain that address, or there is no protected To: Header Field, then the mailing list logs or reports the error, and does not act on that control message.

2.5.5.2. Ignore Legacy Display Elements

Consider the situation where an e-mail based control channel expects to receive an end-to-end encrypted message -- for example, where the control messages need confidentiality guarantees -- and where the action taken depends on the contents of some MIME part within message body.

In this case, the automated system that decrypts the incoming messages and scans the relevant MIME part **MUST** identify when the MIME part contains a Legacy Display Element (see Section 2.5.3.3.1), and it **MUST** parse the relevant MIME part with the Legacy Display Element removed.

For example, consider an administrative interface of a confidential issue tracking software. An authorized user can confidentially adjust the status of a tracked issue by a specially-formatted first line of the message body (for example, severity #183 serious). When the user's MUA encrypts a plain text control message to this issue tracker, depending on the MUA's HCP and its choice of legacy value, it may add a Legacy Display Element. If it does so, then the first line of the message body will contain a decorative copy of the confidential Subject: Header Field. The issue tracking software decrypts the incoming control message, identifies that there is a Legacy Display Element in the part (see Section 2.5.3.3.1), strips the lines comprising the Legacy Display Element (including the first blank line), and only then parses the remaining top line to look for the expected special formatting.

2.5.6. Affordances for Debugging and Troubleshooting

Note that advanced users of an MUA may need access to the original message, for example to troubleshoot problems with the rendering MUA itself, or problems with the SMTP transport path taken by the message.

An MUA that applies these rendering guidelines **SHOULD** ensure that the full original source of the message as it was received remains available to such a user for debugging and troubleshooting.

If a troubleshooting scenario demands information about the cryptographically-protected values of Header Fields, and the message is encrypted, the debugging interface **SHOULD** also provide a "source" view of the Cryptographic Payload itself, alongside the full original source of the message as received.

2.5.7. Rendering Other Schemes

Other MUAs may have generated different structures of messages that aim to offer end-to-end cryptographic protections that include Header Protection. This document is not normative for those schemes, and it is NOT RECOMMENDED to generate these other schemes, as they can either have structural flaws or simply render poorly on Legacy MUAs. A conformant MUA MAY attempt to infer Header Protection when rendering an existing message that appears to use some other scheme not documented here. Pointers to some known other schemes can be found in Appendix E.

2.5.8. Composing a Reply to an Encrypted Message with Header Protection

When composing a reply to an encrypted message with Header Protection, the MUA is acting both as a receiving MUA and as a sending MUA. Special guidance applies here, as things can go wrong in at least two ways: leaking previously-confidential information, and replying to the wrong party.

2.5.8.1. Avoid Leaking Encrypted Header Fields in Reply

As noted in Section 5.4 of [I-D.ietf-lamps-e2e-mail-guidance], an MUA in this position MUST NOT leak previously-encrypted content in the clear in a follow-up message. The same is true for protected Header Fields.

Values from any Header Field that was identified as either encrypted-only or signed-and-encrypted based on the steps outlined above MUST NOT be placed in cleartext output when generating a message.

In particular, if Subject was encrypted, and it is copied into the draft encrypted reply, the replying MUA MUST obfuscate the unprotected (cleartext) Subject Header Field as described above.

When crafting the Header Fields for a reply message, the composing MUA can make use of the HP-Removed and HP-Obscured Header Fields from within the Cryptographic Envelope of the reference message to ensure that Header Fields derived from the reference message do not leak in the reply.

Consider a Header Field in a reply message that is generated by derivation from a Header Field in the reference message. For example, the To Header Field is typically derived from the reference message's Reply-To or From Header Fields. When generating the outer copy of the Header Field, the composing MUA first applies its own Header Confidentiality Policy. If the Header Field's value is changed by the HCP, then it is applied to the outside header and

noted in the protected Header Section using HP-Removed or HP-Obscured as appropriate, as described in Section 2.3.3. Otherwise, if the Header Field's value is unchanged, the composing MUA re-generates the Header Field using the source Header Fields from the values within the Cryptographic Payload of the reference message, as modified by the HP-Obscured or HP-Removed Header Fields. If that value is itself different than the protected value, then it is applied to the outside header and noted in the protected Header Section using HP-Obscured. If the value is the same as the protected value, then it is simply copied to the outside header directly.

See Appendix C.2 for a simple worked example of this process.

2.5.8.2. Avoid Misdirected Replies to Encrypted Messages with Header Protection

When replying to a message, the Composing MUA typically decides who to send the reply to based on:

- * the Reply-To, Mail-Followup-To, or From Header Fields
- * optionally, the other To or Cc Header Fields (if the user chose to "reply all")

When a message has Header Protection, the replying MUA MUST populate the destination fields of the draft message using the protected Header Fields, and ignore any unprotected Header Fields.

This mitigates against an attack where Mallory gets a copy of an encrypted message from Alice to Bob, and then replays the message to Bob with an additional Cc to Mallory's own e-mail address in the message's outer (unprotected) Header Section.

If Bob knows Mallory's certificate already, and he replies to such a message without following the guidance in this section, it's likely that his MUA will encrypt the cleartext of the message directly to Mallory.

2.5.9. Implicitly-rendered Header Fields

While From and To and Cc and Subject and Date are often explicitly rendered to the user, some Header Fields do affect message display, without being explicitly rendered.

For example, Message-Id, References, and In-Reply-To Header Fields may collectively be used to place a message in a "thread" or series of messages.

In another example, Section 2.5.8.2 observes that the value of the Reply-To field can influence the draft reply message. So while the user may never see the Reply-To Header Field directly, it is implicitly "rendered" when the user interacts with the message by replying to it.

An MUA that depends on any implicitly-rendered Header Field in a message with Header Protection MUST use the value from the protected Header Field, and SHOULD NOT use any value found outside the cryptographic protection unless it is known to be a Header Field added in transit, as specified in Section 2.5.10.

2.5.10. Unprotected Header Fields Added in Transit

Some Header Fields are legitimately added in transit, and could not have been known to the sender at message composition time.

The most common of these Header Fields are Received and DKIM-Signature, neither of which are typically rendered, either explicitly or implicitly.

If a receiving MUA has specific knowledge about a given Header Field, including that:

- * the Header Field would not have been known to the original sender, and
- * the Header Field might be rendered explicitly or implicitly,

then the MUA MAY decide to operate on the value of that Header Field from the unprotected Header Section, even though the message has Header Protection.

The MUA MAY prefer to verify that the Header Fields in question have additional transit-derived cryptographic protections before rendering or acting on them. For example, the MUA could verify whether these Header Fields are covered by an appropriate and valid ARC-Authentication-Results (see [RFC8617]) or DKIM-Signature (see [RFC6376]) Header Field.

Specific examples of user-meaningful Header Fields commonly added by transport agents appear below.

2.5.10.1. Mailing list Header Fields: List-* and Archived-At

If the message arrives through a mailing list, the list manager itself may inject Header Fields (most of which start with List-) in the message:

- * List-Archive
- * List-Subscribe
- * List-Unsubscribe
- * List-Id
- * List-Help
- * List-Post
- * Archived-At

For some MUAs, these Header Fields are implicitly rendered, by providing buttons for actions like "Subscribe", "View Archived Version", "Reply List", "List Info", etc.

An MUA that receives a message with Header Protection that contains these Header Fields in the unprotected section, and that has reason to believe the message is coming through a mailing list MAY decide to render them to the user (explicitly or implicitly) even though they are not protected.

2.5.11. Handling Undecryptable Messages

An MUA might receive an apparently encrypted message that it cannot currently decrypt. For example, when an MUA does not have regular access to the secret key material needed for decryption, it cannot know the cryptographically protected Header Fields, or even whether the message has any cryptographically protected Header Fields.

Such an undecrypted message will be rendered by the MUA as a message without any Header Protection. This means that the message summary may well change how it is rendered when the user is finally able to supply the secret key.

For example, the rendering of the Subject Header Field in a mailbox summary might change from [...] to the real message subject when the message is decrypted. Or the message's placement in a message thread might change if, say, References or In-Reply-To have been removed or obscured (see Section 2.5.9).

Additionally, if the MUA does not retain access to the decrypting secret key, and it drops the decrypted form of a message, the message's rendering may revert to the encrypted form. For example, if a MUA follows this behavior, the Subject Header Field in a mailbox summary might change from the real message subject back to [...]. Or, the message might be yanked out of its current thread if the MUA loses access to a removed References or In-Reply-To header.

These behaviors are likely to surprise the user. However, an MUA has several possible ways of reducing or avoiding all of these surprises, including:

- * Ensuring that the MUA always has access to decryption-capable secret key material.
- * Rendering undecrypted messages in a special quarantine view until the decryption-capable secret key material is available.

To reduce or avoid the surprises associated with a decrypted message with removed or obscured Header Fields becoming undecryptable, the MUA could also:

- * Securely cache metadata from a decrypted message's protected Header Fields so that its rendering doesn't change after the first decryption.
- * Securely store the session key associated with a decrypted message, so that attempts to read the message when the long-term secret key are unavailable can proceed using only the session key itself. See, for example, the discussion about stashing session keys in Section 9.1 of [I-D.ietf-lamps-e2e-mail-guidance].

3. E-mail Ecosystem Evolution

This document is intended to offer tooling needed to improve the state of the e-mail ecosystem in a way that can be deployed without significant disruption. Some elements of this specification are present for transitional purposes, but would not exist if the system were designed from scratch.

This section describes these transitional mechanisms, as well as some suggestions for how they might eventually be phased out.

3.1. Dropping Legacy Display Elements

Any decorative Legacy Display Element added to an encrypted message that uses the Injected Header scheme is present strictly for enabling Header Field visibility (most importantly, the Subject Header Field) when the message is viewed with a decryption-capable Legacy MUA.

Eventually, the hope is that most decryption-capable MUAs will conform to this specification, and there will be no need for injection of Legacy Display Elements in the message body. A survey of widely-used decryption-capable MUAs might be able to establish when most of them do support this specification.

At that point, a composing MUA could make the legacy parameter described in Section 2.3.4 to false by default, or could even hard-code it to false, yielding a much simpler message construction set.

Until that point, an end user might want to signal that their receiving MUAs are conformant to this draft so that a peer composing a message to them can set legacy to false. A signal indicating capability of handling messages with Header Protection might be placed in the user's cryptographic certificate, or in outbound messages.

This draft doesn't attempt to define the syntax or semantics of such a signal.

3.2. Stronger Default Header Confidentiality Policy

This draft defines two different forms of Header Confidentiality Policy. An MUA implementing an HCP for the first time SHOULD deploy `hcp_minimal` as recommended in Section 2.4. This HCP offers the most commonly-expected protection (obscuring the Subject Header Field) without risking deliverability or rendering issues.

The HCPs proposed in this draft are relatively conservative and still leak a significant amount of metadata for encrypted messages. This is largely done to ensure deliverability (see Section 1.4.2) and usability, as messages without some critical Header Fields are more likely to not reach their intended recipient.

In the future, some mail transport systems may accept and deliver messages with even less publicly-visible metadata. Many MTA operators today would ask for additional guarantees about such a message to limit the risks associated with abusive or spammy mail.

This specification offers the HCP formalism itself as a way for MUA developers and MTA operators to describe their expectations around message deliverability. MUA developers can propose a stronger default HCP, and ask MTA operators (or simply test) whether their MTAs would be likely to deliver or reject encrypted mail with that HCP applied. Proponents of a stronger HCP should explicitly document the HCP, and name it clearly and unambiguously to facilitate this kind of interoperability discussion.

Reaching widespread consensus around a stronger global default HCP is a challenging problem of coordinating many different actors. A piecemeal approach might be more feasible, where some signalling mechanism allows a message recipient, MTA operator, or third-party clearinghouse to announce what kinds of HCPs are likely to be deliverable for a given recipient. In such a situation, the default HCP for an MUA might involve consulting the signalled acceptable HCPs for all recipients, and combining them (along with a default for when no signal is present) in some way.

If such a signal were to reach widespread use, it could also be used to guide reasonable statistical default HCP choices for recipients with no signal.

This draft doesn't attempt to define the syntax or semantics of such a signal.

3.3. Deprecation of Messages Without Header Protection

At some point, when the majority of MUA clients that can generate cryptographically protected messages with Header Protection, it should be possible to deprecate any cryptographically protected message that does not have Header Protection.

For example, as noted in Section 4.1, it's possible for an MUA to decline to render a signed-only message that has no Header Protection the same as an unsigned message. And a signed-and-encrypted message without Header Protection could likewise be marked as not fully protected.

These stricter rules could be adopted immediately for all messages. Or an MUA developer could roll them out immediately for any new message, but still treat an old message (based on the Date Header Field and cryptographic signature timestamp) more leniently.

A decision like this by any popular receiving MUA could drive adoption of this standard for sending MUAs.

4. Usability Considerations

This section describes concerns for MUAs that are interested in easy adoption of Header Protection by normal users.

While they are not protocol-level artifacts, these concerns motivate the protocol features described in this document.

See also the Usability commentary in Section 2 of [I-D.ietf-lamps-e2e-mail-guidance].

4.1. Mixed Protections Within a Message Are Hard To Understand

When rendering a message to the user, the ideal circumstance is to present a single cryptographic status for any given message. However, when message Header Fields are present, some message Header Fields do not have the same cryptographic protections as the main message.

Representing such a mixed set of protection statuses is very difficult to do in a way that a normal user can understand without training. There are at least three scenarios that are likely to be common, and poorly understood:

- * A signed message with no Header Protection.
- * A signed-and-encrypted message with no Header Protection.
- * An signed-and-encrypted message with Header Protection as described in this document, where some User-Facing Header Fields have confidentiality but some do not.

An MUA should have a reasonable strategy for clearly communicating each of these scenarios to the user. For example, an MUA operating in an environment where it expects most cryptographically-protected messages to have Header Protection could use the following rendering strategy:

- * When rendering a message with signed-only cryptographic status but no Header Protection, an MUA may decline to indicate a positive security status overall, and only indicate the cryptographic status to a user in a message properties or diagnostic view. That is, the message may appear identical to an unsigned message except if a user verifies the properties through a menu option.
- * When rendering a message with signed-and-encrypted or encrypted-only cryptographic status but no Header Protection, overlay a warning flag on the typical cryptographic status indicator. That

is, if a typical signed-and-encrypted message displays a lock icon, display a lock icon with a warning sign (e.g., an exclamation point in a triangle) overlaid. See, for example, the graphics in [chrome-indicators].

- * When rendering a message with signed-and-encrypted or encrypted-only cryptographic status, with Header Protection, but where the Subject Header Field has not been removed or obscured, place a warning sign on the on the Subject line.

Other simple rendering strategies could also be reasonable.

4.2. Users Should Not Have To Choose a Header Confidentiality Policy

This document defines the abstraction of a Header Confidentiality Policy object for the sake of communication between implementers and deployments.

Most e-mail users are unlikely to understand the tradeoffs between different policies. In particular, the potential negative side effects (e.g. poor deliverability) may not be easily attributable by a normal user to a particular HCP.

Therefore, MUA implementers should be conservative in their choice of default HCP, and should not require the Ordinary User to make an incomprehensible choice that could cause unfixable, undiagnosable problems. The safest option is for the MUA developer to select a known, stable HCP (this document recommends `hcp_minimal` in Section 2.4) on the user's behalf. An MUA should not expose the Ordinary User to a configuration option where they are expected to manually select (let alone define) an HCP.

4.3. Users Should Not Have To Choose a Header Protection Scheme

This document also describes two different Header Protection schemes: Wrapped Messages in Section 2.2 and Injected Headers in Section 2.1.

These distinct schemes are described for the sake of implementers who may have to deal with messages found in the wild, but their intended semantics are identical. They represent different tradeoffs in terms of rendering and user experience on the recipient's side, things that a given user writing a message is not prepared to select.

When composing a message with cryptographic protections, the Ordinary User should not be confronted with any choices about which Header Protection scheme to use. Rather, the MUA developer should use a single scheme for all outbound cryptographically-protected messages.

This document recommends the Injected Headers scheme for generating messages with cryptographic protections, as described in Section 2. An MUA should not expose the Ordinary User to any configuration option where they are expected to manually select, enable, or disable Header Protections for new cryptographically-protected messages.

5. Security Considerations

This document describes a mechanism for improving the security of cryptographically-protected e-mail messages. Following the guidance in this document should improve security for users of these technologies by more directly aligning the underlying messages with user expectations about confidentiality, authenticity, and integrity.

However, many existing messages with cryptographic protections will not have these protections, and MUAs encountering these messages will need to handle older forms (without Header Protection) for quite some time. An implementation that deals with legacy message archives will need to deal with all the various formats forever. Helping the user distinguish between cryptographic protections of various messages is a difficult job for message renderers.

However, on the message generation side, the situation is much clearer: there is a standard form that a protected message can take, and an implementer can always generate the standard form. Generating the standard form also makes it more likely that any receiving implementation will be able to handle the generated message appropriately.

The security considerations from Section 6 of [RFC8551] continue to apply for any MUA that offers S/MIME cryptographic protections, as well as Section 3 of [RFC5083] (Authenticated-Enveloped-Data in CMS) and Section 14 of [RFC5652] (CMS more broadly). Likewise, the security considerations from Section 8 of [RFC3156] continue to apply for any MUA that offers PGP/MIME cryptographic protections, as well as Section 13 of [I-D.ietf-openpgp-crypto-refresh-13] (OpenPGP itself). In addition, these underlying security considerations are now also applicable to the contents of the message header, not just the message body.

5.1. Caution about Composing with Legacy Display Elements

When composing a message, it's possible for a Legacy Display Element to contain risky data that could trigger errors in a rendering client.

For example, if the value for a Header Field to be included in a Legacy Display Element within a given body part contains folding whitespace, it should be "unfolded" before generating the Legacy Display Element: all contiguous folding whitespace should be replaced with a single space character. Likewise, if the header value was originally encoded with [RFC2047], it should be decoded first to a standard string and re-encoded using the charset appropriate to the target part.

When including a Legacy Display Element in a text/plain part (see Section 2.3.4.1), if the decoded Subject Header Field contains a pair of newlines (e.g., if it is broken across multiple lines by encoded newlines), any newline MUST be stripped from the Legacy Display Element. If the pair of newlines is not stripped, a receiving MUA that follows the guidance in Section 2.5.3.3.2 might leave the later part of the Legacy Display Element in the rendered message.

When including a Legacy Display Element in a text/html part (see Section 2.3.4.2), any material in the header values should be explicitly HTML escaped to avoid being rendered as part of the HTML. At a minimum, the characters <, >, and & should be escaped to <;, >;, and &;, respectively (see for example [HTML-ESCAPES]). If unescaped characters from removed or obscured header values end up in the Legacy Display Element, a receiving MUA that follows the guidance in Section 2.5.3.3.3 might fail to identify the boundaries of the Legacy Display Element, cutting out more than it should, or leaving remnants visible. And a Legacy MUA parsing such a message might misrender the entire HTML stream, depending on the content of the removed or obscured header values.

The Legacy Display Element is a decorative addition solely to enable visibility of obscured or removed Header Fields in decryption-capable Legacy MUAs. When it is produced, it should be generated conservatively and narrowly, as described above, to avoid damaging the rest of the message.

6. Privacy Considerations

6.1. Some Encrypted Header Fields Are Not Always Private

For encrypted messages, depending on the sender's HCP, some Header Fields may appear both within the Cryptographic Envelope and on the outside of the message (e.g. Date might exist identically in both places). Section 2.5.2 identifies such a Header Field as signed-only. These Header Fields are clearly not private at all, despite a copy being inside the Cryptographic Envelope.

A Header Field whose name can be found in the HP-Removed or in any HP-Obscured Header Field from the same part will have encrypted-only or signed-and-encrypted status. But even Header Fields with these stronger levels of cryptographic confidentiality protection might not be as private as the user would like.

For example, even if the Date Header Field has been obscured, for example by normalizing the timezone to UTC or rounding to the most recent minute or hour (so that Header Field is formally signed-and-encrypted), the MTAs which handle the message can of course record the time that they first encountered it, which is likely to be identical or very close to the original value of the field.

6.2. Header Fields Can Leak Unwanted Information to the Recipient

For encrypted messages, even with an aggressive HCP that successfully obscures most Header Fields from all transport agents, Header Fields will be ultimately visible to all intended recipients. This can be especially problematic for Header Fields that are not user-facing, which the sender may not expect to be injected by their MUA. Consider the three following examples:

- * The MUA may inject a User-Agent Header Field that describes itself to every recipient, even though the sender may not want the recipient to know the exact version of their OS, hardware platform, or MUA.
- * The MUA may have an idiosyncratic way of generating a Message-ID header, which could embed the choice of MUA, a timezone, a hostname, or other subtle information to a knowledgeable recipient.
- * The MUA may erroneously include a Bcc Header Field in the origheaders of a copy of a message sent to the named recipient, defeating the purpose of using Bcc instead of Cc (see Section 6.3 for more details about risks related to Bcc).

Clearly, no end-to-end cryptographic protection of any Header Field as described in this document will hide such a sensitive field from the intended recipient. Instead, the composing MUA MUST populate the origheaders list for any outbound message with only information recipient should have access to. This is true for messages without any cryptographic protection as well, of course, and it is even worse there: such a leak is exposed to the transport agents as well as the recipient. An encrypted message with Header Protection and a strong Header Confidentiality Policy avoid these leaks exposing information to the transport agents, but cannot defend against such a leak to the recipient.

6.2.1. Encrypted Header Fields Can Be Inferred From External or Internal Metadata

For example, if the To: and Cc: Header Fields are omitted from the unprotected Header Section, the values in those fields might still be inferred with high probability by an adversary who looks at the message either in transit or at rest. If the message is found in, or being delivered to a mailbox for bob@example.org, it's likely that Bob was in either To: or Cc:. Furthermore, encrypted message ciphertext may hint at the recipients: for S/MIME messages, the RecipientInfo, and for PGP/MIME messages the key ID in the Public Key Encrypted Session Key (PKESK) packets will all hint at a specific set of recipients. Additionally, an MTA that handles the message may add a Received: Header Field (or some other custom Header Field) that leaks some information about the nature of the delivery.

6.2.2. HCP May Not Mask All Data in an Encrypted Header Field

In another example, if the HCP modifies the Date: header to mask out high-resolution time stamps (e.g. rounding to the most recent hour) and to convert the local timezone to UTC, some information about the date of delivery will still be attached to the e-mail. At the very least, the low resolution, global version of the date will be present on the message. Additionally, Header Fields like Received that are added during message delivery might include higher-resolution timestamps. And if the message lands in a mailbox that is ordered by time of receipt, even its placement in the mailbox and the non-obscured Date: Header Fields of the surrounding messages could leak this information.

Some fields like From: may be impossible to fully obscure, as many modern message delivery systems depend on at least domain information in the From: field for determining whether a message is coming from a domain with "good reputation" (that is, from a domain that is not known for leaking spam). So even if an aggressive HCP opts to remove the human-readable part from any From: Header Field, and to standardize/genericize the local part of the From: address, the domain will still leak.

6.2.3. A Naive Recipient May Overestimate the Cryptographic Status of a Header Field in an Encrypted Message

When an encrypted (or signed-and-encrypted) message is in transit, an active intermediary can strip or tamper with any Header Field that appears outside the Cryptographic Envelope. A receiving MUA that naively infers cryptographic status from differences between the external Header Fields and those found in the Cryptographic Envelope could be tricked into overestimating the protections afforded to some

Header Fields.

For example, if the original sender's HCP passes through the Cc: Header Field unchanged, a cleanly-delivered message would indicate that the Cc: Header Field has a cryptographic status of signed. But if an intermediary attacker simply removes the Header Field from the unprotected Header Section before forwarding the message, then the naive recipient might believe that the field has a cryptographic status of signed-and-encrypted.

This draft offers protection against such an attack by way of the HP-Obscured and HP-Removed Header Fields that can be found on the Cryptographic Payload. If a Header Field appears to have been obscured, but no HP-Obscured header matches it; or if the Header Field appears to have been removed, but the HP-Removed header does not include its field name, the receiving MUA can indicate to the user that the Header Field in question may not have been confidential.

In such a case, a conservative MUA may render the Header Field in question as signed (because the sender did not hide it), but still treat it as signed-and-encrypted during reply, to avoid accidental leakage of the cleartext value in the reply message, as described in Section 2.5.8.1.

6.2.4. Summary and Implementation Guidance

In the abstract sense, the above concerns are of course also true for any encrypted data, including the body of the message: if the sender isn't careful, the message contents or session keys could leak in many different ways that are beyond the scope of this draft. The message recipient has no way in principle to tell whether the apparent confidentiality of any given piece of encrypted content has been broken via channels that they cannot perceive. And an active intermediary aware of the recipient's public key can always encrypt a cleartext message in transit to give the recipient a false sense of security.

Despite the external inferrability of some encrypted or signed-and-encrypted Header Fields, the MUA should still strive to avoid additional leakage of these Header Fields, as described in Section 2.5.8.1.

6.3. Privacy and Deliverability Risks with Bcc and Encrypted Messages

As noted in Section 9.3 of [I-D.ietf-lamps-e2e-mail-guidance], handling Bcc when generating an encrypted e-mail message can be particularly tricky. With Header Protection, there is an additional wrinkle. When an encrypted e-mail message with Header Protection has a Bcc'ed recipient, and the composing MUA explicitly includes the Bcc'ed recipient's address in their copy of the message (see the "second method" in Section 3.6.3 of [RFC5322]), that Bcc Header Field will always be visible to the Bcc'ed recipient.

In this scenario, though, the composing MUA has one additional choice: whether to hide the Bcc Header Field from intervening message transport agents, by returning null when the HCP is invoked for Bcc. If the composing MUA's rationale for including an explicit Bcc in the copy of the message sent to the Bcc recipient is to ensure deliverability via a message transport agent that inspects message Header Fields, then stripping the Bcc field during encryption may cause the intervening transport agent to drop the message entirely. This is why Bcc is not explicitly stripped in `hcp_minimal`.

If, on the other hand, deliverability to a Bcc'ed recipient is not a concern, the most privacy-preserving option is to simply omit the Bcc Header Field from the protected Header Section in the first place. An MUA that is capable of receiving and processing such a message can infer that since their user's address was not mentioned in any To or Cc Header Field, they were likely a Bcc recipient.

Please also see Section 9.3 of [I-D.ietf-lamps-e2e-mail-guidance] for more discussion about Bcc and encrypted messages.

7. IANA Considerations

This document requests IANA to register the following two Header Fields in the "Permanent Message Header Field Names" registry within "Message Headers" in accordance with [RFC3864].

| Header Field Name | Template | Protocol | Status | Reference |
|-------------------|----------|----------|----------|--------------------------|
| HP-Removed | | mail | standard | Section 2.3.3 of RFCXXXX |
| HP-Obscured | | mail | standard | Section 2.3.3 of RFCXXXX |

Table 1: Additions to 'Permanent Message Header Field Names' registry

The Author/Change Controller of these two entries (Section 4.5 of [RFC3864]) should be the IETF itself.

This document also defines the Content-Type parameter known as protected-headers. Consequently, the Content-Type row in the "Permanent Message Header Field Names" registry should add a reference to this RFC to its "References" column.

That is, the current row:

| Header Field Name | Template | Protocol | Status | Reference |
|-------------------|----------|----------|--------|-----------|
| Content-Type | | MIME | | [RFC4021] |

Table 2: Existing row in 'Permanent Message Header Field Names' registry

Should be updated to have the following values:

| Header Field Name | Template | Protocol | Status | Reference |
|-------------------|----------|----------|--------|------------------------|
| Content-Type | | MIME | | [RFC4021] [RFCXXXX] |

Table 3: Replacement row in 'Permanent Message Header Field Names' registry

This document also requests IANA to create a new registry in the "Mail Parameters" protocol group (<https://www.iana.org/assignments/mail-parameters/>) titled Mail Header Confidentiality Policies with the following content:

| Header Confidentiality Policy Name | Description | Reference | Recommended |
|------------------------------------|---|------------------------|-------------|
| hcp_null | No header confidentiality | RFCXXX (this document) | N |
| hcp_minimal | Subject Header Field is obscured | RFCXXX (this document) | Y |
| hcp_strong | Remove or obscure everything but From, Date, To, and Cc | RFCXXX (this document) | N |
| hcp_hide_cc | Obscure Subject, remove Cc | RFCXXX (this document) | N |

Table 4: Mail Header Confidentiality Policies registry

Please add the following textual note to this registry:

The Header Confidentiality Policy Name never appears on the wire. This registry merely tracks stable references to implementable descriptions of distinct policies. Any addition to this registry should be governed by guidance in Section 2.4.4.1 of RFC XXX (this document).

Adding an entry to this registry with an N in the "Recommended" column follows the registration policy of SPECIFICATION REQUIRED. Adding an entry to this registry with a Y in the "Recommended" column or changing the "Recommended" column in an existing entry (from N to Y or vice versa) requires IETF REVIEW. During IETF REVIEW, the designated expert must also be consulted. Guidance for the designated expert can be found in Section 2.4.4.1.

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Appendix A. Possible Problems with some Legacy Clients

When an e-mail message with end-to-end cryptographic protection is received by a mail user agent, the user might experience many different possible problematic interactions. A message with Header Protection may introduce new forms of user experience failure.

In this section, the authors enumerate different kinds of failures we have observed when reviewing, rendering, and replying to messages with different forms of Header Protection in different Legacy MUAs. Different Legacy MUAs demonstrate different subsets of these problems.

A conformant MUA would not exhibit any of these problems. An implementer updating their Legacy MUA to be compliant with this specification should consider these concerns and try to avoid them.

A.1. Problems Reviewing signed-and-encrypted Messages in List View

- * Unprotected Subject, Date, From, To are visible
- * Threading is not visible

A.2. Problems when Rendering a signed-and-encrypted Message

- * Unprotected Subject is visible
- * Protected subject (on its own) is visible in the body
- * Protected subject, date, from, to visible in the body
- * User interaction needed to view whole message
- * User interaction needed to view message body
- * User interaction needed to view protected subject
- * Impossible to view protected subject
- * Nuisance alarms during user interaction
- * Impossible to view message body
- * Appears as a forwarded message
- * Appears as an attachment
- * Security indicators not visible

- * User has multiple different methods to Reply: (e.g. reply to outer, reply to inner)
- * User sees English "Subject:" in body despite message itself being in non-English
- * Security indicators do not identify protection status of Header Fields
- * Header Fields in body render with local Header Field names (e.g. showing "Betreff" instead of "Subject") and dates (TZ, locale)

A.3. Problems when Replying to a signed-and-encrypted Message

Note that the use case here is:

- * User views message, to the point where they can read it.
- * User then replies to message, and they are shown a message composition window, which has some UI elements
- * If the MUA has multiple different methods to Reply: to a message, each way may need to be evaluated separately

This section also uses the shorthand UI:x to mean "the UI element that the user can edit that they think of as x."

- * protected subject is in UI:subject (and will leak)
- * protected subject is quoted in UI:body
- * protected subject is not anywhere in UI
- * message body is not visible/quoted in UI:body
- * user cannot reply while viewing protected message
- * reply is not encrypted by default (but is for normal S/MIME sign+enc messages)
- * unprotected From: is in UI:To
- * User's locale (lang, TZ) leaks in quoted body
- * Header Fields not protected (and in particular, Subject is not obscured) by default

A.4. Problems Reviewing signed-only Messages in List View

- * Unprotected Subject, Date, From, To are visible
- * Threading is not visible

A.5. Problems when Rendering a signed-only Message

- * Unprotected Subject is visible
- * Protected subject (on its own) is visible in the body
- * Protected subject, date, from, to visible in the body
- * User interaction needed to view whole message
- * User interaction needed to view message body
- * User interaction needed to view protected subject
- * Impossible to view protected subject
- * Nuisance alarms during user interaction
- * Impossible to view message body
- * Appears as a forwarded message
- * Appears as an attachment
- * Security indicators not visible
- * Security indicators do not identify protection status of Header Fields
- * User has multiple different methods to Reply: (e.g. reply to outer, reply to inner)
- * Header Fields in body render with local Header Fields (e.g. showing "Betreff" instead of "Subject") and dates (TZ, locale)

A.6. Problems when Replying to a signed-only Message

This uses the same use case(s) and shorthand as Appendix A.3.

- * Unprotected Subject: is in UI:subject
- * Protected Subject: is quoted in UI:body

- * Protected Subject: is not anywhere in UI
- * Message body is not visible/quoted in UI:body
- * User cannot reply while viewing protected message
- * Unprotected From: is in UI:To
- * User's locale (lang, TZ) leaks in quoted body

Appendix B. Test Vectors

This section contains sample messages using the different schemes described in this document. Each sample contains a MIME object, a textual and diagrammatic view of its structure, and examples of how an MUA might render it.

The cryptographic protections used in this document use the S/MIME standard, and keying material and certificates come from [I-D.ietf-lamps-samples].

These messages should be accessible to any IMAP client at `imap://bob@header-protection.cmrg.net/` (any password should authenticate to this read-only IMAP mailbox).

You can also download copies of these test vectors separately at <https://header-protection.cmrg.net>.

If any of the messages downloaded differ from those offered here, this document is the canonical source.

B.1. Baseline Messages

These messages offer no header protection at all, and can be used as a baseline. They are provided in this document as a counterexample. An MUA implementer can use these messages to verify that the reported cryptographic summary of the message indicates no header protection.

B.1.1. No Cryptographic Protections Over a Simple Message

This message uses no cryptographic protection at all. Its body is a text/plain message.

It has the following structure:

text/plain 152 bytes

Its contents are:

```
MIME-Version: 1.0
Content-Type: text/plain; charset="utf-8"
Content-Transfer-Encoding: 7bit
Subject: no-crypto
Message-ID: <no-crypto@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:00:02 -0500
User-Agent: Sample MUA Version 1.0
```

This is the no-crypto message.

This message uses no cryptographic protection at all. Its body is a text/plain message.

--

Alice
alice@smime.example

B.1.2. S/MIME Signed-only signedData Over a Simple Message, No Header Protection

This is a signed-only S/MIME message via PKCS#7 signedData. The payload is a text/plain message. It uses no header protection.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 3852 bytes
  (unwraps to)
  text/plain 204 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="signed-data"
Subject: smime-one-part
Message-ID: <smime-one-part@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:01:02 -0500
User-Agent: Sample MUA Version 1.0
```

```
MIILFwYJKoZIhvcNAQcCoIILCDCCCwQCAQEExDTALBglghkgBZQMEAgEwggFABgkq
hkiG9w0BBWGGggExBIIBLU1JTUUtVmVyc2lvdjogMS4wDQpDb250ZW50LVR5cGU6
IHRleHQvcGxhaW47IGNoYXJzZXQ9InV0Zi04IG0KQ29udGVudC1UcmFuc2Zlci1F
bmNvZGluZz0gN2JpdA0KDQpUaGlzIGlzIHRoZSBzbWltZS1vbmUtcGFydCBtZXNz
YWdlLg0KDQpUaGlzIGlzIGEgc2lnbmVklW9ubHkgUy9NSU1FIG1lc3NhZ2Ugdmlh
```

IFBLQ1MjNyBzaWduZWREYXRhLiAgVGhlDQpwYXl5b2FkIGlzIGEgdGV4dC9wbGFp
biBtZXNzYWdlLiBjdB1c2VzIG5vIGhlYWwcm90ZWNoaW9uLg0KDQotLSAN
CkFsaWNlDQphbGljZUBzbWltZS5leGftcGx1DQqgggemMIIDzCCAgAwIBAgIT
Dy0lvRE5l0rOQ1SHoe49NAaKtDANBgkqhkiG9w0BAQ0FADBMQ0wCwYDVQQKEWRJ
RVRGMREwDwYDVQQLEWhMQU1QUyBXRzExMC8GA1UEAxMoU2FtcGx1IEExBTBTIFJT
QSBdZXJ0aWZpY2F0aW9uIEF1dGhvcml0eTagFw0xOTExMjAwNjU0MThaGA8yMDUy
MDkyNzA2NTQxOFowOzENMASGA1UEChMESUVURjERMA8GA1UECXMITEFNUFMgV0cx
FzAVBgNVBAMTDkFsaWNlIEExvdmVsYWNlMlIBIjANBgkqhkiG9w0BAQEFAAOCAQ8A
MIIBCgKCAQEAmPUp+ovBouOP6AFQJ+RpwpoDxxzY60n1lJ53pTeNSiJlWkwtw/cx
Qq0t4u2vWYB8gOUH/CVt2Zp1c+auzPKJ2Zu5mY6kHm+hVB+IthjLeI7Htg6rNeu
Xq50/TuTSxX5R1I1EXGt8p6hAQVeA5oZ2afHg4b97enV8gozR0/Nkug4AkXmbk7T
HNc8vvjMUJanZ/VmS4TgDqXjWShplcI3lcvvBZMswt41/0HJvmswqps6oQcAx3We
ag0yCNj1V9V9yu/3DjcYbwW2lJf5NbMHbM1LY4X5chWfNEbkN6hQury/zxnlsukg
n+fHbqvWdhJLAqFpW/jA/EB/WI+whUpqtQIDAQABo4GvMIGsMAwGA1UdEwEB/wQC
MAAwFwYDVR0gBBAwDjAMBggpghkgBZQMCAATABMB4GA1UdEQQXMBWBE2FsaWNlQHNT
aWllLmV4YWlwbGUwEwYDVR0lBAwwCgYIKYBBQUHAWQwDgYDVR0PAQH/BAQDAgUg
MB0GA1UdDgQWBBSiU0HVRDyAKRV8ASpw546vzfN3DzAfBgNVHSMEGDAWgBSRMI58
BxcMp/EJKGU2GmccaHb0WTANBgkqhkiG9w0BAQ0FAAOCAQEAgUl4oJyxMpwWpAYl
OvK6NEbM1lgD5H14EC4Muxqlu0q2XgXOSBHI6dFX/4LDsfx7fSIus8gWVY3WqMeu
OA7IizkBD+GDEu8uKveERRXZncxGwy2MfBh1Ib3U8QzTjqB8+dz2AwYeMxODWq9o
pwtA/lTOkRg8uuivZfg/m5fFo/QshlHNaaTDVEXsU4Ps98Hm/3gznbvhdjFbZbi4
oZ3tAadRLE5K9JiQaJYOnUmGpfB8PPwDR6chMZeegSQAW++OIKqHrg/WEh4yiuPf
qmAvX2hzKpPivNJYdTPUXTSO7K459CyqbqG+sNo02kc1nTXl85RHNrVKQK+L0YWY
1Q+hWDCCA88wggK3oAMCAQICEzdBBXntdX9CqaJcOvT4as6aqdcwDQYJKoZIhvcN
AQENBQAwwVTENMASGA1UEChMESUVURjERMA8GA1UECXMITEFNUFMgV0cxMTAvBgNV
BAMTKFNhbXBsZSBMQU1QUyBSU0EgQ2VydgG1maWNhdG1vbiBBdXR0b3JpdHkwIBcN
MTkxMTIwMDY1NDE4WhgPMjA1MjA5MjcWnJjU0MThaMDsxDTALBgNVBAoTBELFVEYx
ETAPBgNVBAsTCEExBTBTIFdHMRcwFQYDVQQDEw5BbGljZSBMb3ZlbGJfZjZTCCASiW
DQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBALTOiehyOBY+TZp/T5K2KNI05Hwr
+E3wP6XTvyi6WWyTgBK9LCOWI2juwdRrjFBSXkk7pWpjXwsA3A5G0tz0FpfgyC7O
xsVcF7q4WHWZwleYXFk1QHJD73nQwXP968+A/3rBX7Ph00DBbZnfitOLPgPEwjTt
dg0VQQ6Wz+CRQ/YbHPKaw7aRphZO63dKvIKp4cQVtkWQH16syTjGsgkLcLNau5LZ
DQUdsGV+SAo3nBdWCRYV+I65x8Kf4hCxxqmjV3d/2NKRu0BXnDe/N+iDz3X0zEoj
0fqXgq4SWcC0nsG1llyXt1TL270I6ATKRGJWiQVCCpDtc0NT6vdJ45bCSzsCawEA
AaOBrzCBrdAMBgNVHRMBAf8EAjAAMBcGA1UdIAQQMA4wDAYKYIZIAWUDAgEwATAe
BgNVHREEFzAVgRNhbGljZUBzbWltZS5leGftcGx1MBMGAlUdJQQMMAoGCCsGAQUF
BwMEMA4GA1UdDwEB/wQEAwIGwDAdBgNVHQ4EFgQUu/bMsi0dBhIcl64papAQ0yBm
ZnMwHwYDVR0jBBBgwFoAUKTCOfAcXDKfxcShlNhpHGh29FkwDQYJKoZIhvcNAQEN
BQADggEBAH0JoJanzqmgasN3/gqSQ4cbbmdj/R40BEPr+gXT+xiidfZ2iLWYyTn
euK6AChwKfnNvOfb8lVliffRtF/KtmVEDMR/sYeqAH83KM5p3el2lVh4OHhyI0qN
uz5oShNaACSioQ23WxHGvy9vsdVfnbhsplrwg9NQ2WbpCmK+2oMh2oYl0Z/wvXmt
9cG6jbMvcdH4z0IOvg6mrYkKTM/RCGnumghxwYToj1OyD5Gs4D2IJCw+fx5ODxh5
2MbNRYXTus2ZPRPM8JXNQC4GWv4km3M4rKnJDd6hnoQ9rNeozIcBVyybQYjfrgg4
DRvw9Ksk22OH4ConlB8f7R7s1LM2cSYxggIAMIIB/AIBATBsMFUxDALBgNVBAoT
BELFVEYxETAPBgNVBAsTCEExBTBTIFdHMTewLwYDVQQDEyhtYWlwbGUgTEFNUFMg
U1NBIEENlcnRpZmljYXRpb24gQXV0aG9yaXR5AhM3QQV57XV/QqmiXDr0+GrOmgnX
MASGCWCGSAFlAwQCAaBpMBGCSqGSIb3DQEJAJazELBgkqhkiG9w0BBwEwHAYJKoZI
hvcNAQkFMQ8XDITxMDIyMDElMDEwMlowLwYJKoZIhvcNAQkEMSIEIESMi+9/LULD

```
fGjj+6U50VNLfxbzvYVJ0wzwnTS114DyMA0GCSqGSib3DQEBAQUABIIBACJHeayB
U1lC4GdcgdojTUjoeIy6UIbrSg/aKZgAkCB8Dwq0hdU10qiun6WKI/TxM5izpRvL
UsNBGMqknPBMFhvwX6KCrwFk0p0j5Y5DZqX30deiQiGTUv3NiWZGTrKJ3JkyymFO
HGbe5Thrq3inRLVfilEuIZewaJsnJhKfnEq9fS09icTJ5olPDAH6mZbW6hpYmU3F
KBk2qJNqJX6bo60rCogu3wXDj0wxnqEXmeNDH5/+L9UVZur+EWzviUc8Ldd/kP3L
DOO7ivs10bAWe8Tbw7NjuP8ZlVvzcVj3nXWzZzxh2ymDIOvyJA+t0LHQvsN/fbdW
fC6Pm51fEkabbmw=
```

B.1.3. S/MIME Signed-only multipart/signed Over a Simple Message, No Header Protection

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a text/plain message. It uses no header protection.

It has the following structure:

```
multipart/signed 4191 bytes
  text/plain 224 bytes
  application/pkcs7-signature [smime.p7s] 3429 bytes
```

Its contents are:

```
MIME-Version: 1.0
Content-Type: multipart/signed;
  protocol="application/pkcs7-signature"; boundary="052";
  micalg="sha-256"
Subject: smime-multipart
Message-ID: <smime-multipart@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:02:02 -0500
User-Agent: Sample MUA Version 1.0
```

--052

```
MIME-Version: 1.0
Content-Type: text/plain; charset="utf-8"
Content-Transfer-Encoding: 7bit
```

This is the smime-multipart message.

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a text/plain message. It uses no header protection.

--

```
Alice
alice@smime.example
```


--052

Content-Transfer-Encoding: base64

Content-Type: application/pkcs7-signature; name="smime.p7s"

MI1J4AYJKoZiIhvcNAQcCoIIJ0TCCc0CAQExDTALBglghkgBZQMEAgEwCwYJKoZiIhvcNAQcBoIIHpjCCA88wggK3oAMCAQICEw8tJb0ROZdKzkJUH6HuPTQGirQwDQYJKoZiIhvcNAQENBQAwVTENMASGA1UEChMESUVURjERMA8GA1UECxMITEFNUFMgV0cxMTAvBgNVBAMTKFNhbXBsZSBMQU1QUyBSU0EgQ2VydGlmawNhdGlvbiBBdXRob3JpdHkwIBcNMtkxMTIwMDY1NDE4WhgPMjA1MjA5MjcwNjU0MThtaMDsxDTALBgNVBAOTBELFVEYxETAPBgNVBAsTCEXBTvBTIFdHMRcwFQYDVQQDEw5BbGljZSBMb3Z1bGFjZTCCASUwDQYJKoZIhvcNAQEBBQAGPAPADCCAAQCGgEBAJqVKfqLwaLjj+gBCfkaCTKtq8cc2OtJ9ZSed6U3JUoiZVpMLcP3MUKtLeLg9rlmAfIDlB/wlbmdadXPMrsyidmbuZmOpB5voVQfilyYYy3iOx7Y0qzXrl6udP07k0sv+UdSNRFxfRkeoQEFXgOaGdmnx4OG/e3plfIKM0dPzZLoOAJF5m500xzXPL74zFCWp2f1ZkuE4A6141koaZXC5XL7wWTLMLenF9Byb5ksKqUuqEHAMdlnmoNMgjY9VfVfcrv9w43GG8FtpSX+TwzB2zNS2OF+XIVnzRG5DeoULq8v88Z5bLpIJ/nx26r8A4SSwIBaVv4wPxAf1iPsIVKaruCAwEAAAOBrzCBrdAMBgvNHRMBAf8EAjAAMBCGA1UdIAQOMA4wDAYKYIZIAWUDAgEwATAeBgNVHREEFzAVGRNhbGljZUBzbWltZS5leGftcGx1MBMGGA1UdJQQMMAoGCCsGAQUFBwMEMA4GA1UdDwEB/wQEAwIFIDAdBgNVHQ4EFgQUo1NB1UQ8gCkVfAEj8OeOr83zdw8wHwYDVR0jBBGwFoAUkTCOfAcXDKfxCSHlNhpnHGh29FkwDQYJKoZIhvcNAQENBQADggEBAIFJeKCCsTKcFqQMPTryujRGzJdYA+R9eBAuDLsatbtKt14FzkgRyOg31/+Cw7H8e30iLrPIFlWN1qjHrjgOyIs5AQ/hgxLvLir3hEUvZ23MRsmthj2h9SG91PEM046gfPnc9gmGHjMTgl1qvaKLPQ5UgZEYPLsr2X4P5uXxaP0LIRZzWmkw1RF7FOD7PFb5v94m5274XYxw24uKGD7QZnUZPORSySgKiWdP1JhqXwFdz8A0enITGXnoEkAFvviCqh64P1hIeMorj36pgL19oWZD6YrzSWHuZ1F00juyuOfQsqm6hvrDTqNpHNZ015fOURza1SkCvi9GFmNUPoVgwggPPMIICt6ADAgECAhM3QQV57XV/QqmiXDr0+GrOmgnXMA0GCSqGSIb3DQEBDQUAMFUxDTALBgNVBAOTBELFVEYxETAPBgNVBAsTCEXBTvBTIFdHMTewLwYDVQQDEyhTYWw1bWGUgTEFNUFMgU1NB1EN1cnRpZmljYXRpb24gQXV0aG9yaXR5MCAXDTE5MTEyMDA2NTQxOFoYDzIwNTIwOTI3MDY1NDE4WjA7MQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEwhMQU1QUyBXRzEXMBUGA1UEAxMOQWxpY2UgTG92ZWxhY2UwggEiMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEKAAIBAQCo9InoWDgWPK2af0+StijSNOR8K/hN8D+l078oullsk4ASvSwjSCNo7sSHUa4xQU15JO6VqY18LANwORjrc9BaX4MguzsbfXBE6uFh1mVpXmFxsPUBYQ+950MFz/evPgP96wv+z4TtAwWZ234rTiz4DxmSI07XYNFUE0ls/gkUP2Gxzyms02kaYWTut3SryCqeHEFBzFtB4urMk4xrIJC3CzWruS2Q0FhbBlfkgKN5wXvkgWfFiOucfCn+IQsaqpold3f9jSkbtAV5w3vzfog8919MxKi9H614KuElnAtJ7BtZcs17dUy9u9C0GeykRiVokFQggQ7XNDU+r3SeOWwks7AgMBAAGjga8wgawwDAYDVR0TAQH/BAIwADAXBgNVHSAEEDAOMAAGCmCGSAFlAwIBMAEwHgYDVR0RBBCwFYETYWxpY2VAc21pbWUuZXhhbXBsZTATBgNVHSUEDDAKBggrBgEFBQcDBDAOBgNVHQ8BAf8EBAMCBsAwHQYDVR0OBByEFvLv2ZLithQYSHJeuKWQqENMgZmZzMB8GA1UdIwQYMBaAFJewjnwHFwyn8QkoZTYaZxxodvRZMA0GCSqGSIb3DQEBDQUAA4IBAQBziaI2p86poGkjD/4KkkOHG25nY/0eNARD6/oF0/sYonX2doizcGmk53riugAocCn5zbzhW/JVdYn30UxfyrZ1RAzEf7GHqgB/Nyjoad3pdpVYeDh4ciNKjbs+aEoTWgAkoqENT1sRxlcvb7HVX524bKZaloPTUNlm6QpivtqDIdqGJdGf8L1zLfxBuo2zL3HR+M9CDr4Opq2JCkzP0Qhp7poIccGE6I9Tsg+RrOA9iCQsPn1+Tg8YedjGzUWF07rNmT0tzPCVzUAoBlr+JtZOkYpyQ3eoZ6EPazXqBMHVAcsmOGI364IOA0b8PSrJntjh+AtqJ5QfH+0e7NSzNnEmMYICADCCAfWCAQEWbDYwCwYDVQQKEwRJRVRGMREwDwYDVQQLEwhMQU1QUyBXRzExMC8GA1UEAxMoU2FtcGx1IEExBTvBTIFJTQSBdZXJ0aWZpY2F0aW9uIEF1dGh

```

cm10eQITN0EFee11f0Kpolw69PhqzpqplzALBglghkgBZQMEAgGgaTAYBgkqhkiG
9w0BCQMxCwYJKoZIhvcNAQcBMBwGCSqGSIb3DQEJBTEPFw0yMTAyMjAxNTAyMDJa
MC8GCSqGSIb3DQEJBDEiBCDAkJYHqVAHhprkzEWP6PweksoYhj5ULTLlbcfQ9Tu3C
zDANBgkqhkiG9w0BAQEFAASCAQCEJe818STb4M4utvQsdCQEH0CZR7I38uL5TSZF3
1lKmD9PuCDuV3GIkfdmZISKRuffBle1xANc2av/0Qogr7OaFF485DAONVAEIQ7ah
t94pwgAE4yvXXWKmFQkKidltnMXbnHADKWU0YC+BQkgd/5J3zg4ESeMwOUm0+b3C
GDauBTIJhHfu9sqt7jXa7PbzQEfemYZORPI14/uZSs86SLkPvNGUpWb4mN6o1C0
2h/U4SCpq80y390oNM0VNpoa+nsTu5yOFc34pMIvjwCJyIOYPaDnvw9FYgr2oOp7
cdOgFcSJ8q7I+Tx2yg60VW8tAT7UBkifc37UUuVbnOsqeVB3

```

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B.1.4. S/MIME Encrypted and Signed Over a Simple Message, No Header Protection

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses no header protection.

It has the following structure:

```

application/pkcs7-mime [smime.p7m] 6720 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 3960 bytes
    (unwraps to)
    text/plain 239 bytes

```

Its contents are:

```

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: smime-enc-signed
Message-ID: <smime-enc-signed@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:03:02 -0500
User-Agent: Sample MUA Version 1.0

```

```

MIITXAYJKoZIhvcNAQcDoIITTTTCCE0kCAQAxxggMQMIIBhAIBADBbsMFUxDTALBgNV
BAoTBELFVEYxETAPBgNVBAsTCExBTvBTIFdHMTewLwYDVQQDEyhTYW1wbGUgTEFN
UFMgU1NBIElnRnRpb24gQXV0aG9yaXR5AhMPLSW9ETmXSs5CVIeh7j00
Boq0MA0GCSqGSIb3DQEBAQUABIIBAHmnSO2IdHZqhpStR4KWdgv3WQtCaxYUhXTJ
AmWV0NBvy5u7gilyKnpqY7CcJ4T5bA68lWNos4i4D2bsiLDGtMAuEynCKejeKp+r
rS6BU+ii3QArUw8v4xxFHmYtOdge1tV1uws7atc8fXnUlgcfpnOD+IvLodwkrJBs
o0AePTxqKmi3pUkSoZ4FVkfXJNkM3KKLXsqf5VFJV21r/AY+3w5V5sFkengnXv6e
kAZWUVMZ5GiiLzCk54l2rGO3Wi5oC1cYqkbnmKndm2MvcwEosO48N6XTvW9geENp
y9stPxv9pAp9HD4miuwWA2KlUPBVLh7l7XwjDwA08MGsRCzHP64wggGEAgEAMGww

```

VTENMASGA1UEChMESUVURjERMA8GA1UECxMITEFNUFMgV0cxMTAvBgNVBAMTKFNh
bXBsZSBMQU1QUyBSU0EgQ2VydGhmaWNhdG1vbiBBdXR0b3JpdHkCEzB8R0APhiY6
HGLS64MvlsDXhpQwDQYJKoZIhvcNAQEBBQAEggEAdOnjKorhe+/7PA3sZPAMGBA6
bQlRDw3HF8/5y4ld+ZCHw02YeGKvc4OT1TO4SsY8zdOhNBhJRaQqRkK+5HKOOPqV
ADA6a90U36FAyNI0Zn8veG4rH1b/vWHVdxWbOW69Liymia3fBz65o/6E1yX/GAb8
m+KPtKx9cvSFCazv95M4C3Girn8LkAswtmwR+deEp7tYPdjHky7TOkdXpV/z0Ee9
HtjilLeqUD+mvV3CJkIbywsUBRsZ0iLA8B9WoIsvcpYDU1biAxMko0rWlUFh2VSD
j6+Tj1W90dSZM7xUF1YefRDd9XnF+HcRNbO58ucu8iIMxVJq+LNBey4N70XmfjCC
EC4GCSqGSib3DQEHATAdbG1ghkgBZQMEAAIEEMyuzbDBN6Tv2WSNq2aSZ5WAghAA
nq1HK1EGkfDdd9BKbpZgRqgsSUEEBdGSgAC4v0Ugu6eD+ukLBk+TzZGuLHFj1vB3
/Nk6mjv4xakp/x23yGk7zc6bzmHduR27avvu9zZf8fdeNMkwBeuB47WIXEnQKmlt
y6I7vVEJJE4CEVF0VDIFH7B2wpo5pogs0N3vJt/Gr2vAO2NjRosgGuHTRDXybQlY
KZKOCw2G0+vB1CYCP9YeM5gG7vQNirjQdVPJOK+4NOEHY8JZHQZvu7dR2P02/QiS
5p8wcYPSRLSWRdaPaBDnfkDTWaaQYUcm909iydoYUI5Xg33LzjGh0UMDg0vouQ/1
Aqj7zwHXfHJVkj381SQc8fL88/TaCkouGMAw/dHCUQYOB5v4JlsSaYBo8ojaPIIk
T6PYuFUo01ghi56h21sKNsuhnYSR8c8rZMq3jIKDkmdjOpNpn6kevuLBHeNnH1wK
WPBiMx4CAapizFjeVmbgnFbjNBdw2kO55bPqXrHMOG5/hHC85JV/IgCF0uvQgOY/
kG2eTl80pJ3dF3/iJnHsn6wB50UDPYAqXt9bpAgtNNd0iCyd5Gd3guQOCAfvpBOO
IkMPH2K8xsvqk6cUncEtrbSColrldePnQhiTiwyAmJevan++mvjUuBRPN1grXH4v
AeCR28K+htOxC/5SaONcLX6FhppXOMR09j4nlwLWvvXfmm0Bo3eyaYqLAatmId1/
igl7gk0JQBw2zzZHqEm1URQh50r/6DvStMj2ASjGgtSPPhBQKO+CaITceLhuRNyw
cH3tSLeGmhMj01DT6gmB/d3PFcLjUx8DwCwYsshDY3Z15GrzIqljgZvmzjBxaCuA
VPGA3jWMOwBdJtXhAP7uYCe5qjbTL9L6EqIo8RQl7zrXxP7etwSjbAFbTUKBxxik
AZKPAGoTFsO3cVhUBmSzoMupgiUAieTOOS43iP9JeXLfHOnN+cAlo7iJx/gEcL68
1ENpSaWRV00NbtF6vjpNIEh7eNOMCA/fTipRR7Pz+g2oKQLUZPNkVxUTI7PjoSPb
bfKpK0xbHqao40mJdNvX6lmg73PsQnJGadYu6DnMvVG7oTibcsA3aoh3jreb1vLO
mzpATxg4b1QFC0Cjxqd8FKRxQZlync5cO5E3EhY1VXW0pi17wW/a2Ca7S8iT3+Rw
bVNd2A01JgS6r+NsvgIXQTjxA6RNzP3K1Iorkuhg6nNbqgJffskHz5uD72AXQc9J
OfxGIFAgNlbnr9u+pvj3WVqJLZTHFdDvvXPGza5/D3tnoWb83j8Z9T8pxlTGK3m2
GVFm4CyJxdzDrOcFxnRO3lYkNeTA01SySF0yhTHAZIOU8lYaUT/2P4y28Fc/79w
ofFZSqVz+J2QCoGbZfbWsJ8RbrcaPYzPj0cBWtUxPyCni0Mf/4if+GxLv1F8a7DI
onHVJg5w+Lo1RKcvPpRIrq/w7wrwFOhEehyQr6a/8WbiAOSMMRsQj3+9atQViPFb
QChAtGHq1TMWysVVGod4S3OhkiOsp1s6tOFCJb8QIL2DY1DSbg/wtnNbWA0Bxytf
tR1bhQRI0ytm7mhN01kfW+dWXPqzofRG/zvaKIGoufnmqJpbk4RR4r+KHUZ3xDP
2URkSh5Qrf9yZ7wE791QKomGSZygvX1Tp8TzicUWpeTQB0IHxsCg2JBtykU3q3m/
SV1NY16oP6oClvVAzRNxQgs6TQ8PEgGqPse323VDCpgAnqsA5zq5zeZjjEK8p+Zy
HWjcaWf1top6+19Tt/5chnAmCk4wS120Lkisu7fOzB9M8UzQC0yVrJ4L1A/MD73Q
KE1zP92o87ZfJnnNjpBb4A/EcBTmhVxbjS1C4cT6UR08pv0cfhSqFni9eMhImQmS
0XST/0NkVeqBmC6b72fATGQb09Iv02pyV/2w5W04gCNCvWBN8kmQQLEEHkDaOmZD
OYxGkgfbT00RxsC2fa8VnRuc8FyRjWFO9qWn8OTNhnVHbd3DPfsoTHN15v7dsGDz
0aOnVMmwSmAFfzQStA9qC+OPeBPXBCKNXd1Y7/7ru00GpUW9hSHKkOc227QtbtTAH
LdUAW1bBIPA3gNJQDkmGQaeFVFJDV8xn9v/lRuVxegh4N8QIK1U9IPz7+wec81S/
4cXz/JT01u/oGpcSE86jzarGMh/ik3ovckGLvH7q7TdT5BdOYyZZa6PcinfkT1Tj
rj/SMsHH3a1XNipnSnb+5OdEIQUJksSgQYE1nFgV2M9PBONy3YA07Z2ArF/f0sEf
hRKQw9YH9grv0beRAOC5182tvvKrZ5j0q6gttYZ8PacoD9DnaXJjNGKJ01jwNsmV
v1Px7G8yOuxx2qUuTBbqr8jHg7XR9/UaYEuvmdSlQZpnuDMOrxuRPuf1InWVZVd7
wxWd588fI3XOXmE9ZA2/kq5uq57xpoRLlPh/sVqVysj9ruYTU7uHz629jFeq5mF4
iIpa80hPVJyC4gDtKLqF8Jb8VVKb4kdbTph6+pcRwnqIj6pEZq4G8FvquntzNn0o

8ydpnyZVV/bu+Py7MYq8YtkcEVvIk70b9gBI3UhKEL1PfRj/t/q0XM2C63a+c93j
YpMSCnb/w0lpy9Ws5VMCISKsDYQLdKwNjj/aYWiHfgyghXGSY8/KDL18Yyzfqz2n
zaOUaFMS7TMvHSjTe6Cv0zIYvht8P6gQmXVvEOLJ1VWUh+q3ccXnW5EHg4CgIbCI
dm5iN3a+OlIejFQSZvFW4kB/RWNsOiYBextmOxxyAmu7xGayLZul/bzBFT5XrQwv
sb524bGOYs6zcKA5z jnkQY215aGztAXFuMkI2nRiUsve5ARm/KQhbl2NGthQu++2
r807AnZGdjhGlz4h5XfR/VvmjuMF/LxdgIJG31VC37u/343lgNbIOWybUorzFaeg
rVnSDvMrfzMdZ/KRLTBhVUC9KFj1hn4L7FdfpWz3LbcW5Kn+uIU6EsRkbdOwdRPN
mEPhgjT/+PD+msMoxTc0kaPtgRgB39I5jnIgPBA08iKtObHttmZoZeqD5+N2uTyK
WB+tC1CctNGGYfCR+YAUMTojhou1FSwiJIBTTE7QmSueuLmrEuCYvxUdEuA7RtTd
LO1Abt0S05WURWu0pNDFroYbYPEjX5vEoFbU5jHhzEZF5WQ3cy+/EqMkxk7/47dh
ux/J9UXXJTyT4Sh8KNZOPh38lcVliqIO/Ms4Nn859zwaFCAKBZxn6ZqFQbBmxZWu
D8ejB8KFxUIUp9H6wSPWvxJ2XW8By01UuZFIE6vvZunm55eYvotkhjQFIag6CzOH
CaUZfwJ6bEWreih4lWFghnRL1ZhRptnfQhnsKKVUqJW0jiaGZNZC+4jVCO+36bo
W9e6LYfkemtKEMer/nrdgvW9LXo2CaL4BNgReK+T4ZkQbyob/2/ADN3mYe+ETBF8
m71lbFEIx73e87xNY2mWhvNMA1/hZ041IJQdPySNwi5V9YE2/cS+6UuLfOVIyxiNG
DpixiwTJroJ6GeKotBn/K5eCqxKoF3gKiH98DnH9NV1otBej74998NG6ATN5jpaZ
C46LiTJpMZpTx91EyasuT6eDW+1EGa6EWylC7x7zjjjwaNlqD2mM1NpnSm8L1oB3
vvcwP60GoLgyu50+M0C+hYxrNuyCG2aoX6bvzdFrh9DyLl8LEErVdOPj9r/hOMtB
PJzmiDqHIYaZv6+uyarrjFRG6d0+kCZDtzuAy/HEU+UXCuv27i99gkEyeMcasQSp
DkRjvnVJQ101fMx/ttIGyyUbTH/jlBmLQ0cc+hrBeGGTYyKM5N6eB5WCukYSkfva
6p7zGiKUEr1py0Zmc04BN3UqPR6P9pJbJ0cNhpCTx7/pKa9OgDpT8+Ma1RxaNOLK
mskKwQpnkJf+2ays9Rv0oYtbNfVzJJPrT8iVglD3aFwmCop0Ml/kW5sYfDpPFgSH
byzTzq3Fjw0AQ5UOG5Qq8EpsAlAJ3hy/5Vv40aVizAoJz2fZXnQ9Bw00lud/outL
ZbRUEC72vJewbIAS1lzdJ7RLlpSMvB48/ca2dgeXqqfnvnAsMzgOilaF1VID9H4m
/KtMJfKPKagrka91wFwLECu207zihtHmRbkkWlrsWqA4SyumWfR5AEGW/sZ8g9LA
rugrt/sE6SpyYi5zzYL9/vNT61kQVy7UhuQcasQU+1CLVuplAk4uvRso88wXYKn
SSQXesmy5m6eYOIevOmyUMQzzfwKswT49j/7hrHsECTzpyCOP0/8zBgGH8f/wglr
/sZ/O+sZnu819qUaJhHSFIEx/CQKuHYv5ez6aT3BAtmPn0iWrFVzna3Ogo8XAL68
eDwN69Qm82ikDO2LFkKZrBzn/ldyZs/dT6lQYpsmhxJzoluZzW/sYFeOCX6fWs7n
fcrz9yMIDKvj70JrZp5jPRghFKHmqo5xh39TmeTsQFp2B8UlGD9YK6YfgSEaGbyL
3BpUjZN/713jmWYHzGvEQfx7vP3SaZBMZ4GSCoeBT2grQoUDe575H7UDJsmRVJ04
bo7iTWpZ1LdIC+oifedAhGhCoum+tApUYj+3BH1xIAZJMCGARqgyKcnvjw5WVu3
fDna+4xJdNs0YK1uBkr6N9FBDfmQIuneIsQHAM7lZfucdlFenZhy1zNreggls9QO
NncRN1ltqmT2qmERXw8/HwcwNjR8FWRwbCCApSMAZ0xWaRxpEct5lnGNbBpplEn
BrMafVecUlQgwaljchA5ZiOuaZxizilPr9/eaX93aa2u+6OpsyPqdadxwDeV1Do
4dg2NrDqQMfO3i1lCaDeZEceqPx8PV0tYjEeFZYsE0k3Qmcti+RuRj/rNTaxQ2Xw
VkgL1BG8POkxw0pVIKVyevcPtUD5tSlTxfp4qBF1EY/yrGCHy36q2mboBcRyYQry
oBnsvoEfrIE8FEz1rOJVM+HN2udrKVJZzEPySf1ZvbDzxINcqDu09r3UO+L+ymW5
9/ncHCMyoa0KbQ08q9i8VsGchL2FF5Q66g7I8U9u7R7V4Fz8RvLOzs6bB/Oh7+Z9
0dTWreRYp9/82pQ0VSuvkWYiSPwiy37spaE8uALD5MvZOS3CqOwGI+o45uLBP/a6
dgalPv1kThe8/a25+FqiQP6boCsN9wgA+T3v3kRFibzFEtyqX8C6Vu795PpycZ14
/RGFTm2Df/U38DN/mlNhGgM6gMQr1YuSPieFJ+0/ctzGpSaS835d+DkQVvS3zT3/
5EpybkOZrqf6erhNTVa8Onr3ZNdt9QyNUCmwxpYVvV2exwoVfcIjQgCxwehySLW5
UprrvRNghHo0OBMH+UmSggBFT7/omejxHgAJz5WC1/P+DiQ/dZcBK10CRh1ZkocLB
WVpunKTMuLyqSqNG87nzXAgFCLYQRWeCQNCItSbJ4aed+sJIYxmEm2UzyKak9eXI
dCZ/5fHOTmMD1645r/v9eSjeZd7Ed6MhGladuV1Nm9Dl29sIzKcUu3zfZAqBlzFK
1RzPS3IUeM2VEJbK9AowEQ==

B.1.5. No Cryptographic Protections Over a Complex Message

This message uses no cryptographic protection at all. Its body is a multipart/alternative message with an inline image/png attachment.

It has the following structure:

```
multipart/mixed 1406 bytes
  multipart/alternative 794 bytes
    text/plain 206 bytes
    text/html 304 bytes
    image/png inline 232 bytes
```

Its contents are:

```
MIME-Version: 1.0
Content-Type: multipart/mixed; boundary="c39"
Subject: no-crypto-complex
Message-ID: <no-crypto-complex@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:00:02 -0500
User-Agent: Sample MUA Version 1.0
```

```
--c39
MIME-Version: 1.0
Content-Type: multipart/alternative; boundary="05a"
```

```
--05a
Content-Type: text/plain; charset="us-ascii"
MIME-Version: 1.0
Content-Transfer-Encoding: 7bit
```

This is the no-crypto-complex message.

This message uses no cryptographic protection at all. Its body is a multipart/alternative message with an inline image/png attachment.

```
--
Alice
alice@smime.example
--05a
Content-Type: text/html; charset="us-ascii"
MIME-Version: 1.0
Content-Transfer-Encoding: 7bit
```

```
<html><head><title></title></head><body>
```

```

<p>This is the <b>no-crypto-complex</b> message.</p>
<p>This message uses no cryptographic protection at all.  Its body
is a multipart/alternative message with an inline image/png
attachment.</p>
<p><tt>-- <br/>Alice<br/>alice@smime.example</tt></p></body></html>
--05a--

```

```

--c39
Content-Type: image/png
Content-Transfer-Encoding: base64
Content-Disposition: inline

```

```

iVBORw0KGgoAAAANSUhEUgAAABQAAAAUcAYAAACNiR0NAAAAcElEQVR42uVTOxbA
MAgS739nO3TpRw20dqpbfARQEjOywiwYnCtkDKnbcLk66sqlT+zt9cidkE+6KwkZ
sgrzfcqVMpL2jo0447gYDpeArk+OnJHkIhAfTPRicihAf5YJrw7vjv0ZWRWM/uli
vdPf1QZ2kDD9xppd8wAAAAABJRu5ErkJggg==

```

```

--c39--

```

B.1.6. S/MIME Signed-only signedData Over a Complex Message, No Header Protection

This is a signed-only S/MIME message via PKCS#7 signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses no header protection.

It has the following structure:

```

application/pkcs7-mime [smime.p7m] 5249 bytes
  (unwraps to)
  multipart/mixed 1288 bytes
    multipart/alternative 882 bytes
      text/plain 258 bytes
      text/html 353 bytes
      image/png inline 236 bytes

```

Its contents are:

```

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="signed-data"
Subject: smime-one-part-complex
Message-ID: <smime-one-part-complex@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:01:02 -0500
User-Agent: Sample MUA Version 1.0

```


R6chMZeegSQAW++OIKqHrg/WEh4yiuPfqmAvX2hZkPpivNJYdTPUXTS07K459Cyq
bqG+sNo02kc1nTX185RHNrVKQK+L0YWY1Q+hWDCCA88wggK3oAMCAQICEzdBBXnt
dX9CqaJcOvT4as6aqdcwDQYJKoZIhvcNAQENBQAwVTENMAsgA1UEChMESUVURjER
MA8GA1UECxmITEFNUFMgV0cxMTAvBgNVBAMTKFNhbXBsZSBMQU1QUyBSU0EgQ2Vy
dGhmaWNhdGlvbiBBdXRob3JpdHkwIBcNMtkxMTIwMDY1NDE4WhgPMjA1MjA5Mjcw
NjU0MThaMDsxDTALBgNVBAoTBELFVEYxETAPBgNVBAsTCExBTvBTIFdHMRcwFQYD
VQQDEw5BbG1jZSBMb3ZlbGFjZTCCASlwdQYJKoZIhvcNAQEBBQADggEPADCCAQoC
ggEBALTOiehY0BY+TZp/T5K2KNI05Hwr+E3wP6XTvyi6WWyTgBK9LCOWI2juwdRr
jFBSXkk7pWpjXwsA3A5G0tz0FpfgyC70xsVcF7q4WHWZWleYXFKlQHJD73nQwXP9
68+A/3rBX7Ph00DBbZnfitOLPgPEwjTtdg0VQQ6Wz+CRQ/YbHPKaw7aRphZO63dK
vIKp4cQVtkWQH6syTjGsgkLcLNau5LZDQUdsGV+SAo3nBdWCRYV+I65x8Kf4hCx
qqmjV3d/2NKRu0BXnDe/N+iDz3X0zEoj0fqXgq4SWcC0nsG1lyXt1TL270I6ATK
RGJWlQVCCpDtc0NT6vdJ45bCSzsCAwEAAaOBrzCBrdAMBgnVHRMBAf8EAJAAMBcG
A1UdIAQQMA4wDAYKYIZIAWUDAgEwATAeBgNVHREEFzAVgRNhbG1jZUBzbWltZS5l
eGftcGx1MBMGA1UdJQQMMAoGCCsGAQUFBwMEMA4GA1UdDwEB/wQEAwIGwDAdBgNV
HQ4EFgQUu/bMsi0dBhIcl64papAQ0yBmZnMwHwYDVR0jBBGwFoAUKTCOfAcXDKfx
CSHlNhpHGH29FkwDQYJKoZIhvcNAQENBQADggEBAHOJoJanzqmgaSN3/gqSQ4cb
bmdj/R40BEPr+gXT+xiidfZ2iLNwYyTneuK6AChwKfnNvOfb8lVliffRtF/KtmVE
DMR/sYeqAH83KM5p3e12lVh4OHhyI0qNuz5oShNaACSioQ23WxHGvy9vsdVfnbhs
plrWg9NQ2WbpCmK+2oMh2oY10Z/wvXmt9cG6jbMvcdH4z0IOvg6mrYkKTM/RCGnu
mgxhwYToj10yD5Gs4D2IJCw+fX50Dxh52MbNRYXTus2ZPRPM8JXNQc4Gwv4km3M4
rKnJdD6hnoQ9rNeozIcBVyybQYjfrgg4DRvW9Ksk22OH4ConlB8f7R7s1LM2cSYx
ggIAMiIB/AIBATBsMFUxDtALBgNVBAoTBELFVEYxETAPBgNVBAsTCExBTvBTIFdH
MTEwLwYDVRQDEyhtYW1wbGUgTEFNUFMgU1NBIElcnRpZmljYXRpb24gQXV0aG9y
aXR5AhM3QQV57XV/QqmiXDr0+GrOmgnXMASGCWCGSAFlAwQCAaBpMBGCSqGSib3
DQEJAzELBgkqhkiG9w0BBwEwHAYJKoZIhvcNAQkFMQ8XDITxMDIyMDEwMDEwMDEw
LwYJKoZIhvcNAQkEMSIEIMhGVzAx/S4dUwqko0cb+oa+gXfmEqw2Iz+svSKpWzC+
MA0GCSqGSib3DQEBAQUABIIBAGtNM3MMhWZVJdN1nlfSk3mhNk6E+LFoOqG4aiHz
e+HEQjN6bKft5zulMCqh7NKRpRmDcEE9RXDGKGYQ9BKBf6Od/04l0lBY/xpPu9G5
XnUTHN3MmqubrTSP3xxU5AozL8i7XmkB68VxKBQ2YpfcXBFgbuvlc6FXkbbh2QtRX
UgBZEp+GSxG7o0UVJRa97t6wblUdMwaQ1ONrtBsmrO46bThv4cgrlGBvz8tGfHwR
4HbS/Rp+6jNAS0K9fZ0PQxy2b4M4braYg3f1n4q3dDH8N0XiUcwG8FiB9XQo18+d
fdkZwTVUoDHWjSVdIREobdPI2wdpnGxS/AB1VuiYpcebi4o=

B.1.7. S/MIME Signed-only multipart/signed Over a Complex Message, No Header Protection

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a multipart/alternative message with an inline image/png attachment. It uses no header protection.

It has the following structure:

multipart/signed 5234 bytes
multipart/mixed 1344 bytes
multipart/alternative 938 bytes
text/plain 278 bytes
text/html 376 bytes
image/png inline 232 bytes
application/pkcs7-signature [smime.p7s] 3429 bytes

Its contents are:

MIME-Version: 1.0
Content-Type: multipart/signed;
 protocol="application/pkcs7-signature"; boundary="452";
 micalg="sha-256"
Subject: smime-multipart-complex
Message-ID: <smime-multipart-complex@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:02:02 -0500
User-Agent: Sample MUA Version 1.0

--452

MIME-Version: 1.0
Content-Type: multipart/mixed; boundary="ac5"

--ac5

MIME-Version: 1.0
Content-Type: multipart/alternative; boundary="813"

--813

Content-Type: text/plain; charset="us-ascii"
MIME-Version: 1.0
Content-Transfer-Encoding: 7bit

This is the smime-multipart-complex message.

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a multipart/alternative message with an inline image/png attachment. It uses no header protection.

--

Alice
alice@smime.example
--813
Content-Type: text/html; charset="us-ascii"
MIME-Version: 1.0
Content-Transfer-Encoding: 7bit

```
<html><head><title></title></head><body>
<p>This is the <b>smime-multipart-complex</b> message.</p>
<p>This is a signed-only S/MIME message via PKCS#7 detached
signature (multipart/signed). The payload is a
multipart/alternative message with an inline image/png
attachment. It uses no header protection.</p>
<p><tt>-- <br/>Alice<br/>alice@smime.example</tt></p></body></html>
--813--
```

```
--ac5
Content-Type: image/png
Content-Transfer-Encoding: base64
Content-Disposition: inline
```

```
iVBORw0KGgoAAAANSUHEUgAAABQAAAAUCAyAAACNiR0NAAAAcELEQVR42uVTOxbA
MAGS739nO3TpRw20dqpbfARQEjOywiwYnCtkDKnbcLk66sqlT+zt9cidkE+6KwkZ
sgrzfcqVMpL2jo0447gYDpeArk+OnJHkIhAfTPRicihAf5YJrw7vjv0ZWRWM/uli
vdPf1QZ2kDD9xppd8wAAAAABJRu5ErkJggg==
```

```
--ac5--
```

```
--452
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-signature; name="smime.p7s"
```

```
MIIJ4AYJKoZIhvcNAQcCoIIJ0TCCcC0CAQExDTALBg1ghkgBZQMEAgEwCwYJKoZI
hvcNAQcBoIIHpjCCA88wggK3oAMCAQICEw8tJb0ROZdKzkJU6HuPTQGirQwDQYJ
KoZIhvcNAQENBQAwVTENMASGA1UEChMESUVURjERMA8GA1UECzMITEFNUFMgV0cx
MTAvBgNVBAMTKFhnbXBsZSBMQU1QUyBSU0EgQ2VydGlmawNhdGlvbiBBdXRob3Jp
dHkwIBcNMTEwMDY1NDE4WhgPMjA1MjA5MjcwNjU0MThaMDsxDTALBgNVBAOT
BELFVEYxETAPBgNVBAsTCExBTUVTIFdHMRcwFQYDVQQDEw5BbG1jZSBMb3ZlbGFj
ZTCCASIwDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBAlJqVKfLwaLjj+gBUCfk
acKTg8cc20tJ9ZSed6U3jUoiZVpMLcP3MUKtLeLg9r1mAfIDlB/wlbdmadXPmrsz
yidmbuZmOpB5voVQfilyYy3iOx7YOqzXr16udP07k0sV+UdSNRFxrfKeoQEFXgOa
Gdmnx4OG/e3plfIKM0dPzZLoOAJF5m500xzXPL74zFCWp2f1ZkuE4A6141koaZXC
N5XL7wWTLMLenF9Byb5ksKqUuqEHAMdlnmoNMgyY9VfVfcrv9w43GG8FtpSX+TWz
B2zNS2OF+XIVnzRG5DeoULq8v88Z5bLpIJ/nx26r8A4SSwIBaVv4wPxAfliPsIVK
arUCAwEAAaOBrzCBrdAMBgNVHRMBAf8EAjAAMBcGA1UdIAQQMA4wDAYKYIZIAWUD
AgEwATAeBgNVHREEFzAVgRNhbG1jZUBzbWltZS5leGFtcGxlMBMGA1UdJQQMMAoG
CCsGAQUFBwMEMA4GA1UdDwEB/wQEAwIFIDAdBgNVHQ4EFgQUo1NB1UQ8gCkVfAEj
8OeOr83zdw8wHwYDVR0jBBGwFoAUKTCOfAcXDKfxCSH1NhpnHGh29FkwDQYJKoZI
hvcNAQENBQADggEBAIFJeKCsTKCfQqMpTryuJRGzJdYA+R9eBAuDLsatbtKt14F
zkgRyOg31/+Cw7H8e30iLrPIf1WN1qjHrjgOyIs5AQ/hgxLvLir3hEUV2Z3MRsMt
jH2x9SG91PEM046gfPnc9gMGHjMTg1qvaKcLQP5UzpEYPLror2X4P5uXxaP0LIZR
zWmkw1RF7FOD7PFB5v94M5274XYxW2W4uKgd7QGnUZROSvSYkGiWDp1JhQxwfdZ8
A0enITGXnoEkAFvvjiCqh64PlhIeMorj36pgL19oWZD6YrzSWHuZ1F00juyuOfQs
qm6hvrDTqNpHNZ015fOURza1SkCvi9GFmNUPoVgwggPPMIICt6ADAgECAhM3QQV5
7XV/QqmiXDr0+GrOmqnXMA0GCSqGSIb3DQEBAQUAMFUDALBgNVBAOTBELFVEYx
```

ETAPBgNVBAStCExBTVBTIFdHMTEwLwYDVQQDEyhTYWlwbGUgTEFNUFMgU1NBIEI1
cnRpZmljYXRpb24gQXV0aG9yaXR5MCAXDTE5MTEyMDA2NTQxOFoYDzIwNTIwOTI3
MDY1NDE4WjA7MQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEwhMQU1QUyBXRzEXMBUG
A1UEAxMOQWxpY2UgTG92ZWxhY2UwggEiMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEK
AoIBAQC09InoWDgWPK2af0+StijSNOR8K/hN8D+l078oullsk4ASvSwjsCNo7sHU
a4xQU15JO6VqY18LANwORjrc9BaX4MguzsbFXBe6uFhlmVpXmFxSpUByQ+950MFz
/evPgP96wV+z4TtAwW2Z34rTiz4DxMI07XYNFUEOls/gkUP2GxzymsO2kaYWTut3
SryCqeHEFbZFkB4urMk4xrIJC3CzWruS2QOFHbBlfkqKN5wXVgkWFfiOucfCn+IQ
saqpo1d3f9jSkbtAV5w3vzfog8919MxKI9H614KuElnAtJ7BtZcs17dUy9u9COgE
ykRiVokFQgqQ7XNDU+r3SeOWwks7AgMBAAGjga8wgawwDAYDVR0TAQH/BAIwADAX
BgNVHSAEEDAOMAwGCMCGSAFlAwIBMAEwHgYDVR0RBBCwFYETyWxpY2VAc21pbWUu
ZXhhbXBsZTATBgNVHSUEDDAKBggrBgEFBQcDBDAOBgNVHQ8BAf8EBAMCBsAwHQYD
VR0OBBYEFV2Z34rTiz4DxMI07XYNFUEOls/gkUP2GxzymsO2kaYWTut3SryCqe
HEFbZFkB4urMk4xrIJC3CzWruS2QOFHbBlfkqKN5wXVgkWFfiOucfCn+IQsaqpo1
d3f9jSkbtAV5w3vzfog8919MxKI9H614KuElnAtJ7BtZcs17dUy9u9COgEykRiV
okFQgqQ7XNDU+r3SeOWwks7AgMBAAGjga8wgawwDAYDVR0TAQH/BAIwADAXBgNV
HSAEEDAOMAwGCMCGSAFlAwIBMAEwHgYDVR0RBBCwFYETyWxpY2VAc21pbWUuZXh
hbXBsZTATBgNVHSUEDDAKBggrBgEFBQcDBDAOBgNVHQ8BAf8EBAMCBsAwHQYDVR
0OBBYEFV2Z34rTiz4DxMI07XYNFUEOls/gkUP2GxzymsO2kaYWTut3SryCqeHEF
bZFkB4urMk4xrIJC3CzWruS2QOFHbBlfkqKN5wXVgkWFfiOucfCn+IQsaqpo1d3f
9jSkbtAV5w3vzfog8919MxKI9H614KuElnAtJ7BtZcs17dUy9u9COgEykRiVokF
QgqQ7XNDU+r3SeOWwks7AgMBAAGjga8wgawwDAYDVR0TAQH/BAIwADAXBgNVHSA
EEDAOMAwGCMCGSAFlAwIBMAEwHgYDVR0RBBCwFYETyWxpY2VAc21pbWUuZXhhb
XBsZTATBgNVHSUEDDAKBggrBgEFBQcDBDAOBgNVHQ8BAf8EBAMCBsAwHQYDVR0O
BBYEFV2Z34rTiz4DxMI07XYNFUEOls/gkUP2GxzymsO2kaYWTut3SryCqeHEFb
ZFkB4urMk4xrIJC3CzWruS2QOFHbBlfkqKN5wXVgkWFfiOucfCn+IQsaqpo1d3f9
jSkbtAV5w3vzfog8919MxKI9H614KuElnAtJ7BtZcs17dUy9u9COgEykRiVokFQ
gqQ7XNDU+r3SeOWwks7AgMBAAGjga8wgawwDAYDVR0TAQH/BAIwADAXBgNVHSAE
EDAOMAwGCMCGSAFlAwIBMAEwHgYDVR0RBBCwFYETyWxpY2VAc21pbWUuZXhhbXB
sZTATBgNVHSUEDDAKBggrBgEFBQcDBDAOBgNVHQ8BAf8EBAMCBsAwHQYDVR0OBB
YEFV2Z34rTiz4DxMI07XYNFUEOls/gkUP2GxzymsO2kaYWTut3SryCqeHEFbZFk
B4urMk4xrIJC3CzWruS2QOFHbBlfkqKN5wXVgkWFfiOucfCn+IQsaqpo1d3f9jSk
btAV5w3vzfog8919MxKI9H614KuElnAtJ7BtZcs17dUy9u9COgEykRiVokFQgqQ
7XNDU+r3SeOWwks7AgMBAAGjga8wgawwDAYDVR0TAQH/BAIwADAXBgNVHSAEEDA
OMAwGCMCGSAFlAwIBMAEwHgYDVR0RBBCwFYETyWxpY2VAc21pbWUuZXhhbXBsZT
ATBgNVHSUEDDAKBggrBgEFBQcDBDAOBgNVHQ8BAf8EBAMCBsAwHQYDVR0OBBYEF
V2Z34rTiz4DxMI07XYNFUEOls/gkUP2GxzymsO2kaYWTut3SryCqeHEFbZFkB4u
rMk4xrIJC3CzWruS2QOFHbBlfkqKN5wXVgkWFfiOucfCn+IQsaqpo1d3f9jSkbtA
V5w3vzfog8919MxKI9H614KuElnAtJ7BtZcs17dUy9u9COgEykRiVokFQgqQ7XN
DU+r3SeOWwks7AgMBAAGjga8wgawwDAYDVR0TAQH/BAIwADAXBgNVHSAEEDAOMA
wGCMCGSAFlAwIBMAEwHgYDVR0RBBCwFYETyWxpY2VAc21pbWUuZXhhbXBsZTATB
gNVHSUEDDAKBggrBgEFBQcDBDAOBgNVHQ8BAf8EBAMCBsAwHQYDVR0OBBYEFV2Z
34rTiz4DxMI07XYNFUEOls/gkUP2GxzymsO2kaYWTut3SryCqeHEFbZFkB4urMk
4xrIJC3CzWruS2QOFHbBlfkqKN5wXVgkWFfiOucfCn+IQsaqpo1d3f9jSkbtAV5w
3vzfog8919MxKI9H614KuElnAtJ7BtZcs17dUy9u9COgEykRiVokFQgqQ7XNDU+r
3SeOWwks7AgMBAAGjga8wgawwDAYDVR0TAQH/BAIwADAXBgNVHSAEEDAOMAwGCM
CGSAFlAwIBMAEwHgYDVR0RBBCwFYETyWxpY2VAc21pbWUuZXhhbXBsZTATBgNVH
SUE

--452--

B.1.8. S/MIME Encrypted and Signed Over a Complex Message, No Header Protection

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses no header protection.

It has the following structure:

```

application/pkcs7-mime [smime.p7m] 8690 bytes
  (decrypts to)
application/pkcs7-mime [smime.p7m] 5426 bytes
  (unwraps to)
multipart/mixed 1356 bytes
  multipart/alternative 950 bytes
    text/plain 293 bytes
    text/html 388 bytes
    image/png inline 236 bytes

```

Its contents are:

```

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: smime-enc-signed-complex
Message-ID: <smime-enc-signed-complex@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:03:02 -0500
User-Agent: Sample MUA Version 1.0

```

```

MIIZDAYJKoZIhvcNAQcDoIIY/TCCGPkCAQAxggMQMIIBhAIBADBsMFUxDTALBgNV
BAoTBELFVEYxETAPBgNVBAsTCExBTVBTIFdHMTEwLWYDVQQDEyhTYW1wbGUgTEFN
UFMgU1NBIElcnRpb24gQXV0aG9yaXR5AhMPLSW9ETmXSs5CVIeh7j00
BoQUMA0GCsQGS1b3DQEBAQUABIIBAB5TXoiCIIIXehywh5/tdFM72iw946N6OzE
mkIj1x+ShPweKrmTgPxaZbNgZpMdyNetqSXTn5H1ZwUAXOkE+EPp301kveWwxBAM
/Umrz/ODGiYLHWORWh+cPwjo00IHo8IJzmF9FWMr7CKYhvbSZn3AFuERRfEccwH9
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```

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```

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```

B.2. Signed-only Messages

These messages are signed-only, using different schemes of header protection and different S/MIME structure. The use no Header Confidentiality Policy because the hcp is only relevant when a message is encrypted.

B.2.1. S/MIME Signed-only signedData Over a Simple Message, Wrapped Message

This is a signed-only S/MIME message via PKCS#7 signedData. The payload is a text/plain message. It uses the Wrapped Message header protection scheme.

It has the following structure:

```

application/pkcs7-mime [smime.p7m] 4319 bytes
  (unwraps to)
  message/rfc822 inline 642 bytes
    text/plain 228 bytes

```

Its contents are:

```

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="signed-data"
Subject: smime-one-part-wrapped
Message-ID: <smime-one-part-wrapped@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:04:02 -0500
User-Agent: Sample MUA Version 1.0

```

```

MIIMcAYJKoZIhvcNAQcCoIIMYTCCDF0CAQExDTALBglghkgBZQMEAgEwggKZBgkq
hkiG9w0BBWGgggKKBIIChk1JTUUtVmVyc2l1bWVjbogMS4wDQpDb250ZW50LVR5cGU6

```



```
KoZIhvcNAQENBQADggEBAHOJoJanzqmgasN3/gqSQ4cbbmdj/R40BEPr+gXT+xiidfZ2iLNwYyTneuK6AChwKfnNvOFb8lV1iffRTF/KtmVEDMR/sYeqAH83KM5p3e121Vh40HhyI0qNuz5oShNaACSioQ23WxHGvy9vsdVfnbhsplrWg9NQ2WbpCmK+2oMh2oYl0Z/wvXmt9cG6jbMvcdH4z0IOvg6mrYkKTM/RCGnumghxwYToj10yD5Gs4D2IJCw+fX5ODxh52MbNRYXTus2ZPRPM8JXNQ4GWv4km3M4rKnJDd6hnoQ9rNeozIcBVyybQYjfrgg4DRvw9Ksk22OH4ConlB8f7R7s1LM2cSYxggIAMIIB/AIBATBsMFUxDTALBgNVBAoTBE1fVEYxETAPBgNVBAsTCExBTvBTIFdHMTEwLwYDVQQDEyhTYWlwbgUGTEFNUFMgU1NBIE1cnRpZmljYXRpb24gQXV0aG9yaXR5AhM3QQV57XV/QqmiXDr0+GrOmqnXMAsgCWCgsAF1AwQCAaBpMBGCSqGSIb3DQEJAZELBgkqhkiG9w0BwEwHAYJKoZIhvcNAQkFMQ8XDTIxMDIyMDE1MDQwMlowLwYJKoZIhvcNAQkEMSIEIPno+5X5nFLPT0q5vegHgVP4OV2/uzd4xPnLWkqhQYIvMA0GCSqGSIb3DQEBAQUA
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```

B.2.2. S/MIME Signed-only multipart/signed Over a Simple Message, Wrapped Message

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a text/plain message. It uses the Wrapped Message header protection scheme.

It has the following structure:

```
multipart/signed 4562 bytes
  message/rfc822 inline 672 bytes
    text/plain 256 bytes
      application/pkcs7-signature [smime.p7s] 3429 bytes
```

Its contents are:

```
MIME-Version: 1.0
Content-Type: multipart/signed;
  protocol="application/pkcs7-signature"; boundary="8a8";
  micalg="sha-256"
Subject: smime-multipart-wrapped
Message-ID: <smime-multipart-wrapped@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:05:02 -0500
User-Agent: Sample MUA Version 1.0

--8a8
MIME-Version: 1.0
Content-Type: message/rfc822; protected-headers="wrapped"
```

Content-Disposition: inline

MIME-Version: 1.0

Content-Type: text/plain; charset="utf-8"

Content-Transfer-Encoding: 7bit

Subject: smime-multipart-wrapped

Message-ID: <smime-multipart-wrapped@lhp.example>

From: Alice <alice@smime.example>

To: Bob <bob@smime.example>

Date: Sat, 20 Feb 2021 10:05:02 -0500

User-Agent: Sample MUA Version 1.0

This is the smime-multipart-wrapped message.

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a text/plain message. It uses the Wrapped Message header protection scheme.

--

Alice

alice@smime.example

--8a8

Content-Transfer-Encoding: base64

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B.2.3. S/MIME Signed-only signedData Over a Simple Message, Injected Headers

This is a signed-only S/MIME message via PKCS#7 signedData. The payload is a text/plain message. It uses the Injected Headers header protection scheme.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 4234 bytes
  (unwraps to)
  text/plain 239 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="signed-data"
Subject: smime-one-part-injected
Message-ID: <smime-one-part-injected@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:06:02 -0500
User-Agent: Sample MUA Version 1.0
```

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 sl/sczGLBObDAJztOOG7oU83zowcKn0JNse2cKU2eQMAENTuahfaXzVrmbfsW665
 Mrfom9Z/

B.2.4. S/MIME Signed-only multipart/signed Over a Simple Message, Injected Headers

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a text/plain message. It uses the Injected Headers header protection scheme.

It has the following structure:

```
multipart/signed 4487 bytes
  text/plain 258 bytes
  application/pkcs7-signature [smime.p7s] 3429 bytes
```

Its contents are:

```
MIME-Version: 1.0
Content-Type: multipart/signed;
  protocol="application/pkcs7-signature"; boundary="file";
  micalg="sha-256"
Subject: smime-multipart-injected
Message-ID: <smime-multipart-injected@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:07:02 -0500
User-Agent: Sample MUA Version 1.0

--file
MIME-Version: 1.0
Content-Transfer-Encoding: 7bit
Subject: smime-multipart-injected
Message-ID: <smime-multipart-injected@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:07:02 -0500
User-Agent: Sample MUA Version 1.0
Content-Type: text/plain; charset="utf-8"; protected-headers="v1"
```

This is the smime-multipart-injected message.

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a text/plain message. It uses the Injected Headers header protection scheme.

```
--
Alice
alice@smime.example
```

```
--file
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-signature; name="smime.p7s"
```

MIIJ4AYJKoZIhvcNAQcCoIIJ0TCCcC0CAQExDTALBglghkgBZQMEAgEWCWYJKoZI
hvcNAQcBoIIHpjCCA88wggK3oAMCAQICEw8tJb0ROZdKzkJU6HuPTQGirQwDQYJ
KoZIhvcNAQENBQAwVTENMASGA1UEChMESUVURjERMA8GA1UECzMITEFNUFMgV0cx
MTAvBgNVBAMTKFNhbXBsZSBMQUU1QUYBSU0EgQ2VydGlmawNhdGlvbiBBdXRob3Jp
dHkwIBcNMtKxMTIwMDY1NDE4WhgPMjA1MjA5MjcwNjU0MThaMDsxDTALBgNVBAoT
BELFVEYxETAPBgNVBAstCExBTVBTIFdHMRcwFQYDVQQDEw5BbG1jZSBMb3Z1bGFj
ZTCCASIdQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBAJqVKfqLwaLjj+gBUCfk
acKTg8cc2OtJ9ZSed6U3jUoiZVpMLcP3MUKtLeLg9r1mAfID1B/wlbdmadEPmrs
yidmbuZmOpB5voVQfiliYy3iOx7Y0qzXrl6udP07k0sv+UdSNRFxrfKeoQEXFgOa
Gdmnx4OG/e3plfIKM0PpZkLoOAJF5m00xzXPL74zFCWp2f1ZkuE4A6141koazXC
N5XL7wTTLMLenLf9Byb5ksKqUaUEHAMdlnmoNmGjY9VfVfcrv9w43GG8FtpSX+TWZ
B2zNS2OF+XIVnzRG5DeoULq8v88Z5bLpIJ/nx26r8A4SSwIBAv4wPxAf1iPSiVK

arUCAwEAAaOBrzCBrDAMBgNVHRMBAf8EAjaAMBcGA1UdIAQQMA4wDAYKYIZIAWUD
AgEwATAeBgNVHREEFzAVgRNhbG1jZUBzbW1tZS5leGFtcGx1MBMGA1UdJQQMMAoG
CCsGAQUFBwMEMA4GA1UdDwEB/wQEAWIFIDAdBgNVHQ4EFgQUo1NB1UQ8gCkVfAEj
8OeOr83zdw8wHwYDVR0jBBgwFoAUkTCOfAcXDKfxCSh1NhpHGh29FkwDQYJKoZI
hvcNAQENBQADggEBAIFJeKCcsTKcFqQMPTryujRGzJdYA+R9eBAuDLsatbtKt14F
zkgRyOg31/+Cw7H8e30iLrPIf1WN1qjHrjgOyIs5AQ/hgxLvLir3hEUV2Z3MRsMt
jH2x9SG91PEM046gfPnc9gMGHjMTg1qvaKcLQP5UzpeYPLrör2X4P5uXxaP0LIZR
zWmkw1RF7FOD7PFB5v94M5274XYxW2W4uKGd7QGnUZROsvSYkGiWdp1JhqXwFDz8
A0enITGXnoEkAFvvjiCqh64PlhIeMorj36pgL19oWZD6YrzSWHuZ1F00juyuOfQs
qm6hvrDTqNpHNZ015fOURza1SkCvi9GFmNUPoVgwggPPMIICt6ADAgECAhM3QQV5
7XV/QqmiXDr0+GrOmgnXMA0GCSqGSIb3DQEBDQUAMFUxDTALBgNVBAoTBELFVEYx
ETAPBgNVBAStCExBTVBTIFdHMTEwLwYDVQQDEyhTYW1wbGUgTEFNUFMgU1NBIEENl
cnRpZmljYXRpb24gQXV0aG9yaXR5MCAxZTE5MTEyMDA2NTQxOFoYDzIwNTIwOTI3
MDY1NDE4WjA7MQ0wCwYDVQQKEWRJRVRGMREwDwYDVQQLEWhMQU1QUyBXRzEXMBUG
A1UEAxMOQWxpY2UgTG92ZWxhY2UwgGElMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEK
AoIBAQC09InoWDgWPK2af0+StijsNOR8K/hN8D+1078oullsk4ASvSwjsCNo7sHU
a4xQU15JO6VqY18LANwORjrc9BaX4MguzsbFXBe6uFhlmVpXmFxSpUBYQ+950MFz
/evPgP96wV+z4TtAwW2Z34rTiz4DxMI07XYNFUEOlS/gkUP2GxzymsO2kaYWTut3
SryCqeHEFbZfKb4urMk4xrIJC3CzWruS2Q0FHbBlfkgKN5wXVgkWFfiOucfCn+IQ
saqp01d3f9jSkbtAV5w3vzfog8919MxKI9H614KuElNAtJ7BtZcs17dUy9u9C0gE
ykRiVokFQgqQ7XNDU+r3SeOWwks7AgMBAAAgja8wgawwDAYDVR0TAAQH/BAIwADAX
BgNVHSAEEDAOMAAGCmCGSAFlAwIBMAEwHgYDVR0RBBCwFYETYWxpY2VAC21pbWUu
ZXhhbXBsZTATBgNVHSUEDDAKBggrBgEFBQcDBDAOBgNVHQ8BAf8EBAMCBsAwHQYD
VR0OBBYEF1v2zLlthQYSHJeuKWQqENMgZmZzMB8GA1UdIwQYMBaAFJEWjnwHFWyn
8QkoZTYaZxxodvRZMA0GCSqGSIb3DQEBDQUAA4IBAQBziaI2p86poGkjd/4KkkOH
G25nY/0eNARD6/oF0/sYonX2doizcGMk53riugAocCn5zbzhW/JVdYn30UxfyrZ1
RAzEf7GHqgB/NyjoAd3pdpVYeDh4ciNKjbs+aEoTWgAkoqENT1sRx1cvb7HVX524
bKZaloPTUNlm6QpivtqDIdqGJdGf8L1zLfxBuo2zL3HR+M9CDr40pq2JCKzP0Qhp
7poIccGE6I9Tsg+RrOA9iCQsPn1+Tg8YedjGzUWF07rNmT0TzPCVzUAUblR+JJtz
OKypyQ3eoZ6EPazXqMyHAVcsm0GI364IOA0b8PSrJNtjh+AqJ5QfH+0e7NSzNnEm
MYICADCCAfwCAQEwbDBVMQ0wCwYDVQQKEWRJRVRGMREwDwYDVQQLEWhMQU1QUyBX
RzExMC8GA1UEAxMoU2FtcGx1IExBTVBTIFJTQSBdZXJ0aWZpY2F0aW9uIEF1dGhv
cm10eQITN0EFee11f0Kpolw69Phqzppp1zALBg1ghkgBZQMEAgGaTAYBgkqhkiG
9w0BCQMxCwYJKoZIhvcNAQcBMBwGCSqGSIb3DQEJJBTEPFW0yMTAyMjAxNTA3MDJa
MC8GCSqGSIb3DQEJJBDEiBCA6Rhu8s2iPcyWQk+TNKhP9ZHJ9+wulWjsMpAF1NXCE
jDANBgkqhkiG9w0BAQEFAASCAQB4QMAYf42dnAelBRb2NotiixNgdjdSpVK75af6
oND3UjdCWcd4bPbrfTzMQKp0FBP0oft91w2fWNgXwKbhd1cL3RWUmUq0zcNbI3XI
86vWp79p+KwM/+SyDdfgudIRGjbs/tmKaBvaH89a8SvuxhNxxq/pxgDzpy/JWC8Er
AUDTbKrNVsYD+MfzMy9B0TlK2YlK0Q6rV0N1n2nXbW0e+Ztv0a/getNKAEP+5hE
OQkq50RxUP9pI5kQ1NdU6zqCNhRjmd1wnMxn45K+hfy8cxwwemFn94PgDGpPG4mB
yRXQPj+5oyduWiHRMLXG1+fs4tqxHZXN+WaUHvSIDqNXK3rj

--f1e--

ZWQgTWVzc2FnZSBoZWFKZlXIKChJvdGVjdGlvbiBzY2h1bWUuCGotLSAKQWxpY2UK
YWxpY2VAc21pbWUuZlXhXbXBsZQotLTQxMwpDb250ZW50LVR5cGU6IHRleHQvaHRt
bDs9Y2hhcnNldD0idXMtYXNjaWkiCk1JTUUtVmVyc21vb2JogMS4wCkNvbnRlbnQt
VHJhbnNmZXItRW5jb2Rpbmc6IDdiaXQKCjxodGlsPjx0aXR5ZT48L3Rp
dGx1PjwvaGVhZD48Ym9keT4KPHA+VGhpcyBpcyB0aGUgPGI+c21pbWUtb251LXBh
cnQtY29tcGxleC13cmFwcGVkPC9iPiBtZXNzYWdlLjwvcD4KPHA+VGhpcyBpcyBh
IHNpZ251ZC1vbmx5IFMvTU1NRSBtZXNzYWdlIHZpYSBQSO0NTIzcg21nbmVhZGF0
YS4gIFRoZQpwYX1sb2FkIGlzIGEgbXVsdG1wYXJ0L2FsdGVybmF0aXZlIG1lc3Nh
Z2Ugd2l0aCBhbiBpbmxbpbmUKaW1hZ2UvcG5nIGF0dGFjaG1lbnQuIE10IHVzZXMG
dGhlIFdyYXBwZWQgTWVzc2FnZSBoZWFKZlXIKChJvdGVjdGlvbiBzY2h1bWUuPC9w
Pgo8CD48dHQ+LS0gPGJyLz5BbGljZTxici8+YWxpY2VAc21pbWUuZlXhXbXBsZTwv
dHQ+PC9wPjwvYm9keT48L2h0bWw+Ci0tNDEzLS0KCi0tMWQ3CkNvbnRlbnQtVHlw
ZTogaW1hZ2UvcG5nCkNvbnRlbnQtVHJhbnNmZXItRW5jb2Rpbmc6IGJhc2U2NApD
b250ZW50LURpc3Bvc210aW9uOiBpbmxbpbmUKCmlwQk9SczBLR2dvQUFBQU5TVWhF
VWdBQUFBUFBQUFBQU5pUjBOQUFBQUFBQUFBQUFBQUFBQUFBQUFBQUFBQUFBQUFBQU
UzczOW5PM1RwUncyMGRxcGJmQVJRRWpPeXdpdl1uQ3RrREtuYmNMazY2c3FsVCT6
dD1jaWRrRSs2S3drWgpzZ3J6ZmNkVklwTDJqbzA0NDdnWURwZUFyaytPbkpIa0lo
QWZUUFJpY2loQWY1WUpydzd2anYwWldSV00vdWxpCnZkUGYxUVoya0REOXhwcGQ4
d0FBQUFCSlJVNUVya0pnZ2c9PQoKLS0xZDctLQqgggemMIIDzzCCAreAwIBAgIT
Dy0lvRE510rOQ1SHoe49NAaKtDANBgkqhkiG9w0BAQ0FADBMQ0wCwYDVQQKEwRJ
RVRGMRewDwYDVQQLEWhMQU1QUyBXRzExMC8GA1UEAxMoU2FtcGx1IEExBTBVTIFJT
QSBdZXJ0aWZpY2F0aW9uIEF1dGhvcml0eTA9Fw0xOTExMjAwNjU0MTAhaGA8yMDUy
MDkyNzA2NTQxOFowOzENMASGA1UEChMESUVURjERMA8GA1UECXMITEFNUFMgV0cx
FzAVBgNVBAMTDkFsaWN1IEExvdmVsYWN1MIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8A
MIIBCgKCAQEAmPUp+ovBouOP6AFQJ+RpwODxxxY60n1lJ53pTeNSiJlWkwtw/cx
Qq0t4uD2vWYB8gOUH/Cvt2Zp1c+auzPKJ2Zu5mY6kHm+hVB+IthjLeI7Htg6rNeu
Xq50/TuTSxX5R1I1EXGt8p6hAQVeA5oZ2afHg4b97enV8gozR0/Nkug4AkXmbk7T
HNc8vvjMUJanZ/VmS4TgDqXjWShplcI3lcvvBZMswt41/0HJvmsWqps6oQcAx3We
ag0yCNj1V9V9yu/3DjcYbwW2lJf5NbMHbM1LY4X5chWfNEbkN6hQury/zxnlsukg
n+fHbqvwdhJLAgFpW/jA/EB/WI+whUpqtQIDAQAB04GvMIGsMAwGA1UdEwEB/wQC
MAAwFwYDVR0gBBADjAMBgpghkgBZQMCATAMB4GA1UdEQQXMBWBE2FsaWN1QHNT
aW1lLmV4YW1wbGUwEwYDVR01BAwwCgYIKwYBBQUHAwQwDgYDVR0PAQH/BAQDAgUg
MB0GA1UdDgQWBBSiU0HVRDyAKRV8ASpW546vzfN3DzAfBgNVHSMEGDAwGBSRMI58
BxcMp/EJKGU2GmccaHb0WTANBgkqhkiG9w0BAQ0FAAOCAQEAgU14oJyxMpwWpAyl
OvK6NEbm1lgD5H14EC4Muxqlu0q2XgXOSBHI6DfX/4LDsfx7fSIus8gWVY3WqMeu
OA7IizkBD+GDEu8uKveERRXZncxGwy2Mfbh1Ib3U8QzTjqB8+dz2AwYeMxODWq9o
pwtA/1TOKRg8uuiVZfg/m5fFo/Qsh1HNaaTDVEXsU4Ps98Hm/3gznbvhdjFbZbi4
oZ3tAadR1E5K9JiQaJYOnUmGpfB8PPwDR6chMZeegSQAW++OIKqHrg/WEH4yiuPf
qmAvX2hZkPpivNJYdTPUXTSO7K459CyqbqG+sNo02kc1nTX185RHNrVKQK+LOYWY
1Q+hWDCCA88wggK3oAMCAQICEzdBBXntdX9CqaJcOvT4as6aqdcwDQYJKoZIhvcN
AQENBQAQV TENMASGA1UEChMESUVURjERMA8GA1UECXMITEFNUFMgV0cxMTAvBgNV
BAMTKFNhbXBsZSBMQU1QUyBSU0EgQ2VydG1maWNhdGlvbiBBdXRob3JpdHkwIBCN
MTkxMTIwMDY1NDE4WhgPMjA1MjA5MjcWU0MTAhaMDsxDTALBgNVBAoTBElfVEYx
ETAPBgNVBASCEExBTBVTIFdHMRcwFQYDVR0QDEw5BbGljZSBMb3ZlbGFjZTCCASlw
DQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBALTOiehY0BY+TZp/T5K2KNI05Hwr
+E3wP6XTvyy6WWyTgBK9LCOWI2juwdRrjFBSXkk7pWpjXwsA3A5Gotz0FpfgyC7O
xsVcF7q4WHWZwleYXFK1QHJD73nQwXP968+A/3rBX7PhO0DBBznfitOLPgPEwjTt
dg0VQQ6Wz+CRQ/YbHPKaw7aRphZO63dKvIKp4cQVtkWQHi6syTjGsgkLcLNU5LZ

DQUdsGV+SAo3nBdWCRYV+I65x8Kf4hCxqqmjV3d/2NKRu0BXnDe/N+iDz3X0zEoj
 0fqXgq4SWcC0nsG1lyyXt1TL270I6ATKRGJWiQVCCpDtc0NT6vdJ45bCSzsCAwEA
 AaOBrzCBrdAMBgNVHRMBAf8EAjAAMBcGA1UdIAQQMA4wDAYKYIZIAWUDAgEwATAe
 BgNVHREEFzAVgRNhbGljZUBzbWltZS5leGFtcGxlMBMGA1UdJQQMMAoGCCsGAQUF
 BwMEMA4GA1UdDwEB/wQEAwIGwDAdBgNVHQ4EFgQUu/bMsi0dBhIcl64papAQ0yBm
 ZnMwHwYDVR0jBBgwFoAUkTCOfAcXDKfxCSHlNhpnHGh29FkwDQYJKoZIhvcNAQEN
 BQADggEBAHOJoJanzqmgasN3/gqSQ4cbbmdj/R40BEPr+gXT+xiidfZ2iLnWYyTn
 euK6AChwKfnNvOFb8lV1iffRtF/KtmVEDMR/sYeqAH83KM5p3e12lVh4OHhyI0qN
 uz5oShNaACSioQ23WxHGvy9vsdVfnbhsp1rWg9NQ2WbpCmK+2oMh2oYl0Z/wvXmt
 9cG6jbMvcdH4z0IOvg6mrYkKTM/RCGnumghxwYToj1OyD5Gs4D2IJCw+fx5ODxh5
 2MbNRYXTus2ZPRPM8JXNQc4Gwv4km3M4rKnJDd6hnoQ9rNeozIcBVyybQYjfrgg4
 DRvw9Ksk22OH4ConlB8f7R7s1LM2cSYxggIAMIIB/AIBATBsMFUxDtALBgNVBAoT
 BElFVEYxETAPBgNVBAsTCExBTvBTIFdHMTewLwYDVQQDEyhTYWlwbGUgTEFNUFMg
 U1NBIEENlcnRpZmljYXRpb24gQXV0aG9yaXR5AhM3QQV57XV/QqmiXDr0+GrOmgnX
 MAsGCWCGSAFlawQCAaBpMBGCSqGSIb3DQEJAzELBgkqhkiG9w0BBwEwHAYJKoZI
 hvCNQkFMQ8XDTIxMDIyMDE3MDQwMlowLwYJKoZIhvcNAQkEMSIEICsRogMUJrtS
 GAERSFiPMhqWk+9misjv48XcSNJBKUj5MA0GCSqGSIb3DQEBAQUABIIBALJCpfEK
 FQ+M1YQIuTcVEHr/K/w/8ht4pOy4BmEE+q3yZUBATHt37DxdZUXRZjUB52FdsWed
 agkt3DjtFzJwRiDSteChrjrA/0jbFVOuV/9VBm0VGGfodRTovS+6wH+yJNAXHSW9
 p1GXmPcDFAtn5wr69zBNCX5mKU6bwcaVX41S7/fmcD1BNSQ45fx+RrXRhMX/vG2A
 tgu01LuRSCvGgzh719968R5D3obEtZwUi8uSOpv13XqThZC5Q4NMg68UNgNb//OT
 PuaqlMOVhWhSkTNKjbtv2P/MifHWXj9TYHkRc9l5k707LqWj3yWNFR7tpVO07n0+
 hTEzoJRFKuxJlQ4=

B.2.6. S/MIME Signed-only multipart/signed Over a Complex Message, Wrapped Message

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a multipart/alternative message with an inline image/png attachment. It uses the Wrapped Message header protection scheme.

It has the following structure:

```
multipart/signed 5653 bytes
  message/rfc822 inline 1747 bytes
    multipart/mixed 1642 bytes
      multipart/alternative 1002 bytes
        text/plain 310 bytes
        text/html 408 bytes
        image/png inline 232 bytes
        application/pkcs7-signature [smime.p7s] 3429 bytes
```

Its contents are:

MIME-Version: 1.0
Content-Type: multipart/signed;
 protocol="application/pkcs7-signature"; boundary="aa9";
 micalg="sha-256"
Subject: smime-multipart-complex-wrapped
Message-ID: <smime-multipart-complex-wrapped@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:05:02 -0500
User-Agent: Sample MUA Version 1.0

--aa9

MIME-Version: 1.0
Content-Type: message/rfc822; protected-headers="wrapped"
Content-Disposition: inline

MIME-Version: 1.0
Content-Type: multipart/mixed; boundary="a30"
Subject: smime-multipart-complex-wrapped
Message-ID: <smime-multipart-complex-wrapped@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:05:02 -0500
User-Agent: Sample MUA Version 1.0

--a30

MIME-Version: 1.0
Content-Type: multipart/alternative; boundary="844"

--844

Content-Type: text/plain; charset="us-ascii"
MIME-Version: 1.0
Content-Transfer-Encoding: 7bit

This is the smime-multipart-complex-wrapped message.

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a multipart/alternative message with an inline image/png attachment. It uses the Wrapped Message header protection scheme.

--

Alice
alice@smime.example
--844
Content-Type: text/html; charset="us-ascii"
MIME-Version: 1.0

A0enITGXnoEkAFvvjiCqh64PlhIeMorj36pgL19oWZD6YrzSWHUz1F00juyuOfQs
qm6hvrDTqNpHNZ015fOURza1SkCvi9GFmNUPoVgwgGPPMIICt6ADAgECAhM3QQV5
7XV/QqmiXDr0+GrOmgnXMA0GCSqGSib3DQEBDQUAMFUxDTALBgNVBAoTBELFVEYx
ETAPBgNVBAsTCEExBTBTIFdHMTEwLwYDVQQDEyhTYWlwbGUgTEFNUFMgU1NBIEIENl
cnRpZmljYXRpb24gQXV0aG9yaXR5MCAXDTE5MTEyMDA2NTQxOFoYDzIwNTIwOTI3
MDY1NDE4WjA7MQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEWhMQU1QUyBXRzEXMBUG
A1UEAxMOQWxpY2UgTG92ZWxhY2UwgGgEiMA0GCSqGSib3DQEBQUAA4IBDwAwggEK
AoIBAQC09InoWDgWPK2af0+StijSNOR8K/hN8D+1078oullsk4ASvSwjsCNo7sHU
a4xQU15JO6VqY18LANwORjrc9BaX4MguzsbFXBe6uFh1mVpXmFxSpUByQ+950MFz
/evPgP96wV+z4TtAwW2Z34rTiz4DxMI07XYNFUEOlS/gkUP2GxzymsO2kaYWTut3
SryCqeHEFbZfKB4urMk4xrIJC3CzWruS2Q0FHbBlfkgKN5wXVgkWFfiOucfCn+IQ
saqpold3f9jSkbtAV5w3vzfog8919MxKI9H614KuElnAtJ7BtZcs17dUy9u9COgE
yKriVokFQgqQ7XNDU+r3SeOWwks7AgMBAAGjga8wgawwDAYDVR0TAQH/BAIwADAX
BgNVHSAEEEDAOMAAGCmCGSAFLAwIBMAEwHgYDVRORBBCwFYETYWxpY2VAc21pbWUu
ZXhhbXBsZTATBgNVHSUEDDAKBggrBgEFBQcDBDAOBgNVHQ8BAf8EBAMCBsAwHQYD
VR0OBBYEF1v2zLlthQYSHJeuKWqQENMgZmZzMB8GA1UdIwQYMBaAFJEWjnwHFwyn
8QkoZTYaZxxodvRZMA0GCSqGSib3DQEBDQUAA4IBAQBziaI2p86poGkjd/4KkkOH
G25nY/0eNARD6/oF0/sYonX2doizcGMk53riugAocCn5zbzhW/JVdYn30UxfyrZl
RAzEf7GHqgB/NyjOad3pdpVYeDh4ciNKjbs+aEoTWgAkoqENTlsRx1cvb7HVX524
bKZa1oPTUNlm6QpivtqPIdqGJdGF8L1zLFXBu02zL3HR+M9CDr40pq2JckzP0Qhp
7poIccGE6I9Tsq+RrOA9iCQsPn1+Tg8YedjGzUWF07rNmT0TzPCVzUAuBlr+JJtz
OKypyQ3eoZ6EPazXqMyHAVcsm0GI364IOA0b8PSrJNtjh+AqJ5QfH+0e7NSzNnEm
MYICADCCafwCAQEwBDBVMQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEWhMQU1QUyBX
RzExMC8GA1UEAxMoU2FtCGx1IEExBTBTIFJTSBDZlXJ0aWZpY2F0aW9uIEF1dGhv
cm10eQITN0EFee11f0Kpolw69Phqzpp1zALBglghkgBZQMEAgGgATAYBgkqhkiG
9w0BCQMxCwYJKoZIhvcNAQcBMBwGCSqGSib3DQEBJBTBEPFw0yMTAyMjAxNzA1MDJa
MC8GCSqGSib3DQEBJBTBDEiBCDvCBOZJKngosmsBz3B3if2ErlyiRyR1KnTpWbe6AN0
fzANBgkqhkiG9w0BAQEFAASCAQB6Xc+YUIEUCqF3vqlZTP41u/jEG330+bc5jw7D
VLUbKQ+AI6c6602LAgMwX17VuBdbgHecf59trY2F47Wr8N1cbTcAq0jN54tqrhri
8cL4YzS8YGH0vLrDdwilChjs0N1+t5nQ8Rya+rdGqseE0TK38P/K28cnU3udgTjb
6E/QcopIlnLaa+j+x5qjRHq10Yt9tbA5F1L9vgggu7Zf9w55tZie9cESnVZpud/1
+zqsKDFj4ndnMDFzrUtXztY2e1f/Y8EVjSIVtY+ZeYuldtGhPpvk/N3koxZ1yL2Z
mrPQemZ0C2bIet7T1vv7lFCUtU0bdyHoHBvXI7OhbCmGmak3

--aa9--

B.2.7. S/MIME Signed-only signedData Over a Complex Message, Injected Headers

This is a signed-only S/MIME message via PKCS#7 signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme.

It has the following structure:

eGftcGx1PC90dD48L3A+PC9ib2R5PjwvaHRtbD4NCi0tOTA3LS0NCg0KLS0zOTUN
CkNvbnRlbnQtVHlwZTogaW1hZ2UvcG5nDQpDb250ZW50LVRyYW5zMVYLUVUyY29k
aW5nOiBiYXNlNjQNCkNvbnRlbnQtRGlzcG9zaXRpb246IGlubGluZQ0KDQppVkJP
UncwS0dnb0FBQUFOU1VoRVVnQUFBQlFBQUFBVUNBWUFBQUUNoAViWtkFBQUFjRWx
UVZSNDJlVlRPeGJBDQpNQWdTNzM5bk8zVHBSdzIwZHFwYmZBU1FFak95d2l3WW5D
dGtES25iY0xrNjZzcWxUK3p0OWNpZGtFKzZLd2taDQpzZ3J6ZmNwVklwTDJqbzA0
NDdnWURwZUFyaytPbkpIa0loQWZUUFJpY2loQWY1WUpydzd2anYwWldSV00vdWxp
DQp2ZFBNMVFAMmtERDl4cHBkOHdBQUFBQkpSVTVFcmtKZ2dnPT0NCg0KLS0zOTUt
LQ0KoIIHpjCCA88wggK3oAMCAQICEw8tJb0ROZdKzkJU6HuPTQGirQwDQYJKoZI
hvcNAQENBQAwVTENMAsGA1UEChMESUVURjERMA8GA1UECXMITEFNUFMgV0cxMTAv
BgNVBAMTKFNhbXBsZSBMQU1QUyBSU0EgQ2VydGlmaWNhdGlubiBBdXRob3JpdHkw
IBcNMtKxMTIwMDYlNDE4WhgPMjA1MjA5MjcWU0MThaMDsxDTALBgNVBAoTBELF
VEYxETAPBgNVBAsTCExBTBVTIFdHMRcwFQYDVQQDEw5BbG1jZSBMb3ZlbnGFjZTCC
AS1wDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBAJgVKfLwaLjJ+gBUCfkacKT
g8cc20tJ9ZSed6U3jUoiZVpMLcP3MUKtLeLg9r1mAfIDlB/wlbdmadXPmrszyidm
buZmOpB5voVQfiLYYy3iOx7YOqzXrl6udP07k0sv+UdSNRFxrfKeoQEFXgOaGdmn
x4OG/e3p1fIKM0dPzZLoOAJF5m500xzXPL74zFCWp2f1ZkuE4A6141koaZXC5XL
7wWTLMLenF9Byb5ksKqUuqEHAMdlnmoNMgjY9VfVfcrv9w43GG8FtpSX+TwzB2zN
S2OF+XIVnzRG5DeoULq8v88Z5bLpIJ/nx26r8A4SSwIBaVv4wPxAfliPsIVKarUC
AwEAAaOBBrCBrdAMBgNVHRMBAf8EAjAAMBcGA1UdIAQQMA4wDAYKYIZIAWUDAgEw
ATAeBgNVHREEFzAVgRNhbGljZUBzbWltZS5leGftcGx1MBMGA1UdJQQMMAoGCCsG
AQUFBwMEMA4GA1UdDwEB/wQEAwIFIDAdBgNVHQ4EFgQUo1NB1UQ8gCkVfAEj8OeO
r83zdW8wHwYDVR0jBBGwFoAUkTCOfAcXDKfxCSHlNhpHGH29FkwDQYJKoZIhvcN
AQENBQADggEBAIFJeKCsTKcFqQMPTryuJRgzJdYA+R9eBAuDLsatbtKt14Fzkgr
yOg31/+Cw7H8e30iLrPIfLWN1qjHrjgOyIs5AQ/hgxLvLir3hEUV2Z3MRsMtjH2x
9SG91PEM046gfPnc9gMGHjMTg1qvaKcLQP5UzpEYPLror2X4P5uXxaP0LIZRzWmk
w1RF7FOD7Pfb5v94M5274XYxW2W4uKgd7QGnUZROSvSYkGiWdp1JhqXwfdZ8A0en
ITGXnoEkAFvvjiCqh64PlhIeMorj36pgL19oWZD6YrzSWHUz1F00juyuOfQsqm6h
vrDTqNpHNZ015fOURza1SkCvi9GFmNUPoVgwgGPPMIICt6ADAgECAhM3QQV57XV/
QqmiXDr0+GrOmqnXMA0GCSqGS1b3DQEBDQUAMFUXDTALBgNVBAoTBELFVEYxETAP
BgNVBAsTCExBTBVTIFdHMTewLwYDVQQDEyhTYW1wbGUgTEFNUFMgU1NB1EN1cnRp
ZmljYXRpb24gQXV0aG9yaXR5MCAXDTE5MTEyMDA2NTQxOFoYDzIwNTIwOTI3MDY1
NDE4WjA7MQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEWhMQU1QUyBXRzEXMBUGA1UE
AxMOQWxpY2UgTG92ZWxhY2UwggEiMA0GCSqGS1b3DQEBAQUAA4IBDwAwggEKAoIB
AQc09InoWDgWPK2af0+StijSNOR8K/hN8D+1078oullsk4ASvSwjsCNo7sHUa4xQ
U15JO6VqY18LANWORjrc9BaX4MguzsbfXBe6uFhlMvpXmFxSpUByQ+950MFz/evP
gp96wV+z4TtAwW2Z34rTiz4DxMI07XYNFUEOls/gkUP2GxzymsO2kaYWTut3SryC
qeHEfBzFk4urMk4xrIJC3CzWruS2Q0FHbBlfkgKN5wXVgkWFfiOucfCn+IQsaqp
o1d3f9jSkbtAV5w3vzfog8919MxKI9H614KuElnAtJ7BtZcs17dUy9u9C0gEykRi
VokFQgqQ7XNDU+r3SeOWwks7AgMBAAAgjga8wgawwDAYDVR0TAAQH/BAIwADAXBgNV
HSAEEDAOMAAGCmCGSAFlAwIBMAEwHgYDVR0RBBcwFYETYWxpY2VAc2lpbWUuZXhh
bXBsZSBMQU1QUyBSU0EgQ2VydGlmaWNhdGlubiBBdXRob3JpdHkwIBcNMtKxMTIw
MDYlNDE4WhgPMjA1MjA5MjcWU0MThaMDsxDTALBgNVBAoTBELFVEYxETAPBgNVBAs
TCExBTBVTIFdHMTewLwYDVQQDEyhTYW1wbGUgTEFNUFMgU1NB1EN1cnRpZmljYXR
pb24gQXV0aG9yaXR5MCAXDTE5MTEyMDA2NTQxOFoYDzIwNTIwOTI3MDY1NDE4WjA7
MQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEWhMQU1QUyBXRzEXMBUGA1UEAxMOQWxpY2
UgTG92ZWxhY2UwggEiMA0GCSqGS1b3DQEBAQUAA4IBDwAwggEKAoIBAQZYaZxxodvR
ZMA0GCSqGS1b3DQEBAQUAA4IBAQBziaI2p86poGkjD/4KkkOHG25nY/0eNARD6/oF0/
sYonX2doizcGMk53riugAocCn5zbzhW/JVdYn30UxfyrZ1RAZEf7GHqgB/NyjOad3p
dpVYeDh4ciNKjbs+aEoTWgAkoqENT1sRxlcvb7HVX524bkZa1oPTUNlm6QpivtqD
IdqGJdGf8L1zLfXBuo2zL3HR+M9CDr4Opq2JckzP0Qhp7poIccGE6I9Tsg+RrOA9i
CQsPnl+Tg8YedjGzUWF07rNmT0TzPCVzUAuBlr+JJtZOKyp

```
yQ3eoZ6EPazXqMyHAVcsm0GI364IOA0b8PSrJNtjh+AqJ5QfH+0e7NSzNnEmMYIC
ADCCAFwCAQEwbDBVMQ0wCwYDVQKKEwRJRVRGMREwDwYDVQKLEwhMQU1QUyBXRzEx
MC8GA1UEAxMoU2FtcGx1IEExBTBTIFJTQSBDZXJ0aWZpY2F0aW9uIEF1dGhvcml0
eQITN0EFee11f0Kpolw69PhqzpqplzALBglghkgBZQMEAgGgaTAYBgkqhkiG9w0B
CQMxCwYJKoZIhvcNAQcBMBwGCSqGSIb3DQEJBTEPFw0yMTAyMjAxNzA2MDJhMC8G
CSqGSIb3DQEJBDEiBCC84gf/+no5va6ErXhHIk1xELMQNWg9BUh8E1M78W5u5TAN
BgkqhkiG9w0BAQEFAASCAQB+q8buLwucKfPrBoXxKP7ZaJ/ifg8Y4Axf84AhNJXC
+NWzThUSgq12Fn9cdSV0858oDrWDSndd/zwgab0TgQZ+64atwiQ7bVTDkG8qgeT+
I/R1I8jGOCUTpkKcK34tOYbmhkc7/2BLITc3qQAxuN+1rsWVL2NF8LFGH9RbfzRu
WFVqAMyFAo9DRr1PeFDoDQnjAGti37M8/WvftXixxOAevVmFUWbpnFiwvSwdrt0
CKquQ1NYbFAvxOawxLU0jFqhIgWl0+fU4jqQDukUVSKFiw1/dK+7jlZC6sCXf3Ys
oHRhxqY/bSsgXn1DUWSDjhae3Hn1ZuoVXLJDHGCD6oSR
```

B.2.8. S/MIME Signed-only multipart/signed Over a Complex Message, Injected Headers

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme.

It has the following structure:

```
multipart/signed 5580 bytes
  multipart/mixed 1672 bytes
    multipart/alternative 1006 bytes
      text/plain 312 bytes
      text/html 410 bytes
      image/png inline 232 bytes
      application/pkcs7-signature [smime.p7s] 3429 bytes
```

Its contents are:

```
MIME-Version: 1.0
Content-Type: multipart/signed;
  protocol="application/pkcs7-signature"; boundary="f91";
  micalg="sha-256"
Subject: smime-multipart-complex-injected
Message-ID: <smime-multipart-complex-injected@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:07:02 -0500
User-Agent: Sample MUA Version 1.0

--f91
MIME-Version: 1.0
Subject: smime-multipart-complex-injected
Message-ID: <smime-multipart-complex-injected@lhp.example>
```


From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:07:02 -0500
User-Agent: Sample MUA Version 1.0
Content-Type: multipart/mixed; boundary="099"; protected-headers="v1"

--099

MIME-Version: 1.0

Content-Type: multipart/alternative; boundary="9a5"

--9a5

Content-Type: text/plain; charset="us-ascii"

MIME-Version: 1.0

Content-Transfer-Encoding: 7bit

This is the smime-multipart-complex-injected message.

This is a signed-only S/MIME message via PKCS#7 detached signature (multipart/signed). The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme.

--

Alice
alice@smime.example

--9a5

Content-Type: text/html; charset="us-ascii"

MIME-Version: 1.0

Content-Transfer-Encoding: 7bit

```
<html><head><title></title></head><body>
<p>This is the <b>smime-multipart-complex-injected</b> message.</p>
<p>This is a signed-only S/MIME message via PKCS#7 detached
signature (multipart/signed). The payload is a
multipart/alternative message with an inline image/png
attachment. It uses the Injected Headers header protection
scheme.</p>
<p><tt>-- <br/>Alice<br/>alice@smime.example</tt></p></body></html>
--9a5--
```

--099

Content-Type: image/png

Content-Transfer-Encoding: base64

Content-Disposition: inline

iVBORw0KGgoAAAANSUhEUgAAABQAAAAUCAyAAACNiR0NAAAAcELEQVR42uVTOxbA
MAGs739nO3TpRw20dqpbfARQEjOywiwYnCtkDKnbcLk66sqlT+zt9cidkE+6KwkZ

sgrzfcqVMpL2jo0447gYDpeArk+OnJHkIhAfTPRicihAf5YJrw7vjv0ZWRWM/uli
vdPf1QZ2kDD9xppd8wAAAABJRu5ErkJggg==

--099--

--f91

Content-Transfer-Encoding: base64

Content-Type: application/pkcs7-signature; name="smime.p7s"

MIIJ4AYJKoZIhvcNAQcCoIIJ0TCCCC0CAQExDTALBglghkgBZQMEAgEwCwYJKoZI
hvcNAQcBoIIHpjCCA88wggK3oAMCAQICEw8tJb0ROZdKzkJU6HuPTQGirQwDQYJ
KoZIhvcNAQENBQAwVTENMASGA1UEChMESUVURjERMA8GA1UECXMITEFNUFMgV0cx
MTAvBgNVBAMTKFhXbXBSZSBMQU1QUyBSU0EgQ2VydG1maWNhdGlvbiBBdXRob3Jp
dHkwIBcNMtKxMTIwMDY1NDE4WHgPMjA1MjA5MjcwNjU0MThaMDsxDTALBgNVBAoT
BELFVEYxETAPBgNVBAsTCExBTVBTIFdHMRcwFQYDVQQDEw5BbGljZSBMb3ZlbGFj
ZTCCASIdDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBAJqVKfqlWALjj+gBUCfk
acKTg8cc2OtJ9ZSed6U3jUoiZVpMLcP3MUKtLeLg9r1mAfIDlB/wlbdmadXPmrsz
yidmbuZmOpB5voVQfiliYYy3iOx7YOqzXrl6udP07k0sV+UdSNRFxrfKeoQEFXgOa
Gdmnx4OG/e3p1fIKM0dPzZLoOAJF5m500xzXPL74zFCWp2f1ZkuE4A6141koaZXC
N5XL7wWTLMLenF9Byb5ksKqUuqEHAMdlnmoNMgjY9VFVfcrv9w43GG8FtpSX+TWz
B2zNS2OF+XIVnzRG5DeoULq8v88Z5bLpIJ/nx26r8A4SSwIBaVv4wPxAf1iPsIVK
arUCAwEAAaOBrzCBrdAMBgNVHRMBaf8EAJAAMBcGA1UdIAQQMA4wDAYKYIZIAWUD
AgEwATAeBgNVHREEFzAVgRNhbGljZUBzbWltZS5leGftcGx1MBMGA1UdJQQMMAoG
CCsGAQUFBwMEMA4GA1UdDwEB/wQEAwIFIDAdBgNVHQ4EFgQUo1NB1UQ8gCkVfAEj
8OeOr83zdW8wHwYDVR0jBBgwFoAUKTCOfAcXDKfxCSH1NhpNHGh29FkwDQYJKoZI
hvcNAQENBQADggEBAlFJeKCsTKcFqQMPTryujRGzJdYA+R9eBAuDLsatbtKt14F
zkgRyOg31/+Cw7H8e30iLrPIfLWN1qjHrjgOyIs5AQ/hgxLvLir3hEUUV2Z3MRsMt
jH2x9SG91PEM046gfPnc9gMGHjMTg1qvaKcLQP5UzpEYPLror2X4P5uXxaP0LIZR
zWmkw1RF7FOD7Pfb5v94M5274XYxW2W4uKgD7QGnUZROSvSYkGiWdp1JhqXwfDz8
A0enITGXnoEkaFvviCqh64PlhIeMorj36pgL19oWZD6YrzSWHuz1F00juyuOfQs
qm6hvrDTqNpHNZ015fOURza1SkCvi9GFmNUPoVgwgGPPMIICt6ADAgECAhM3QQV5
7XV/QqmiXDr0+GrOmgnXMA0GCSqGSIb3DQEBAQUAMFUDALBgNVBAoTBELFVEYx
ETAPBgNVBAsTCExBTVBTIFdHMTEwLWYDVQQDEyhTYW1wbGUgTEFNUFMgU1NBIE
cnRpZmljYXRpb24gQXV0aG9yaXR5MCAXDTE5MTEyMDA2NTQxOFoYDzIwNTIwOTI3
MDY1NDE4WjA7MQ0wCwYDVQQKEWRJRVRGMREwDwYDVQQLEWhMQU1QUyBXRzEXMBUG
A1UEAxMQWxpY2UgTG92ZWxhY2UwggEiMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEK
AoIBAQC09InoWDgWPk2af0+StijSNOR8K/hN8D+1078oullsk4ASvSwjsCNo7sHU
a4xQU15JO6VqY18LANwORjrc9BaX4MguzsbFXBe6uFh1mVpXmFxpUByQ+950MFz
/evPgP96wV+z4TtAwW2Z34rTiz4DxMI07XYNFUEOlS/gkUP2Gxzyms02kaYWTut3
SryCqeHEFbZfKb4urMk4xrIJC3CzWruS2QOFHbBlfkgKN5wXVgkWFfiOucfCn+IQ
saqpol3f9jSkbtAV5w3vzfog8919MxKI9H614KuElnAtJ7BtZcs17dUy9u9COgE
ykRiVokFQgqQ7XNDU+r3SeOWwks7AgMBAAAgja8wgawwDAYDVR0TAQH/BAIwADAX
BgNVHSAEEDAOMAAGCmCGSAFlAwIBMAEwHgYDVR0RBBCwFYETYWxpY2VAc21pbWUu
ZXhhbXBsZTATBgNVHSUEDDAKBggrBgEFBQcDBDAOBgNVHQ8BAF8EBAMCBsAwHQYD
VR00BBYEFvLv2zLIThQYSHJeuKWQqENMgZmZzMB8GA1UdIwQYMBaAFJEWjnwHFWyn
8QkoZTYaZxxodvRZMA0GCSqGSIb3DQEBAQUAA4IBAQBziaI2p86poGkjD/4KkkOH
G25nY/0eNARD6/0F0/sYonX2doizcGMk53riugAocCn5zbzhW/JVdYn30UxfyrZ1
RAzEf7GHqgB/NyjOad3pdpVYeDh4ciNKjbs+aEoTWgAkoqENT1sRx1lcvb7HVX524

bKZa1oPTUN1m6QpivtqDIdqGJdGf8L1zLfXBuo2zL3HR+M9CDr4Opq2JCKzP0Qhp
 7poIccGE6I9Tsg+RrOA9iCQsPn1+Tg8YedjGzUWF07rNmT0TzPCVzUAuB1r+JJtz
 OKypyQ3eoZ6EPazXqMyHAVcsm0GI364IOA0b8PSrJNtjh+AqJ5QfH+0e7NSzNnEm
 MYICADCCafwCAQEwbDBVMQ0wCwYDVQQKEwRJRVRGMREwDwYDVQQLEwhMQU1QUyBX
 RzExMC8GA1UEAxMoU2FtcGx1IEExBTBVTIFJTQSBDZXJ0aWZpY2F0aW9uIEF1dGhv
 cml0eQITN0EFee11f0Kpolw69Phqzpqp1zALBglghkgBZQMEAgGgaTAYBgkqhkiG
 9w0BCQMxCwYJKoZIhvcNAQcBMBwGCSqGSIb3DQEJBTEPFw0yMTAyMjAxNzA3MDJa
 MC8GCSqGSIb3DQEJBDEiBCDzzjU9zkYamvSgC05wewF4LgTekLa4P8khUZ1HRNkO
 GzANBgkqhkiG9w0BAQEFAASCAQCFAAaiW0Mvy2tnagCpthNu6sAL22/BBu2BS5XY0
 vTH4/MtLzU4lSokfcs8lqpXmE852prfBZfy0BiOtKZF6TkW59XPiEx4TfBZ+pFwb
 MaJbZ5Kil2GpqKib2sEKbaNHaUY0H+vixz3NP6lo2Izras33cw4Z7FE24qs3zTAA
 1WYTF8rtPhXVW9rFLumBOF8LgGKPTh4mjWrAEcaqmqmscibxTJ5yp5DJhHMF9Xv
 /HVi9lOJJ5BlYOQOL/jWPxQorYJAP62HwEEzz7/GE24hm43pK8uHT5DPHiG+gZZL
 35qcfe8j50JVLTG2wcRH/aKhat12MMnPFMqnJGwugLv4rwg5

--f91--

B.3. Encrypted-and-signed Messages

These messages are encrypted and signed. They use PKCS#7 signedData inside envelopedData, with different header protection schemes and different Header Confidentiality Policies.

B.3.1. S/MIME Encrypted and Signed Over a Simple Message, Wrapped Message With hcp_minimal

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Wrapped Message header protection scheme with the hcp_minimal Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 7540 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 4580 bytes
    (unwraps to)
    message/rfc822 inline 783 bytes
      text/plain 321 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <smime-enc-signed-wrapped-minimal@lhp.example>
From: Alice <alice@smime.example>
```

To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:08:02 -0500
User-Agent: Sample MUA Version 1.0

MIIVvAYJKoZIhvcNAQcDoIIIVrTCCFakCAQAxggMQMIIBhAIBADBsMFUxDALBgNV
BAoTBELFVEYxETAPBgNVBAsTCExBTVBTIFdHMTEwLWYDVQQDEyhTYWlwGUGTEFN
UfMgUlnBIEEnlcnRpZmljYXRpb24gQXV0aG9yaXR5AhMPLSW9ETmXSs5CVIeh7j00
Boq0MA0GCSqGSIb3DQEBAQUABIIBAH7NZ5T5anffqtWAgtooMtA/krAJvMnVSghb
3dWk15izranm5qH2EdFCxvdagu4bsboapU7GH2o8sZ+Hr7ExuiAFRSOQMS/wgOgW
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B.3.2. S/MIME Encrypted and Signed Over a Simple Message, Injected Headers With hcp_minimal

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Injected Headers header protection scheme with the hcp_minimal Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 7435 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 4498 bytes
    (unwraps to)
    text/plain 333 bytes
```

Its contents are:

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
smime-type="enveloped-data"
Subject: [...]
Message-ID: <smime-enc-signed-injected-minimal@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:09:02 -0500
User-Agent: Sample MUA Version 1.0

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B.3.3. S/MIME Encrypted and Signed Over a Simple Message, Injected Headers With hcp_minimal (+ Legacy Display)

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Injected Headers header protection scheme with the hcp_minimal Header Confidentiality Policy with a "Legacy Display" part.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 7670 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 4674 bytes
    (unwraps to)
    text/plain 423 bytes
```

Its contents are:

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
smime-type="enveloped-data"
Subject: [...]
Message-ID:
<smime-enc-signed-injected-minimal-legacy@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:10:02 -0500
User-Agent: Sample MUA Version 1.0

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DMefqY+0dE3Pts7J3UXPw8pn0H6ARrZn01euFeHVxMPJU3GPss/1B5Y+xtT2zrVh
j+ouAdHOTxX7VnOwpYi5P91UEdlBOG4ez6eBc3BMVi5Mol1Qgp5Jr6eHrOUi1DEg
+G2HD2jrl/ClhWcPUJSEZqqH3hkhQ25iJxBd0o16F5W7NQ2MLaDeE2/xGZ5OBBPB
stf0dFsoohdVtIM6laOIveZ+TviAh4IlJoHZrmjMRjpZ7vGN1Idjg7z6xM4YYtCl
piJl0n2/rr66+GS7pQcoVOuFAyBnblEglHrJTfDBY6BAgA46Fe03npucYpiBGoFR
4I791+nN85fE+JzuEuny182ui/qtR+PQWeNV/oiV8wmhCez8g2zDmuLwfNcAjjtI
xQSOvH5PNt2XA4OjaJWv8YzHdnEHdSmV0gxm7g7TVeT8Ez866jn93fwoKo17shfZ
9Y7TyDCRICg8hAi/kEM8eRLOG2/Lgb1jMH1HHTZuguE3DYf+LhGXkcvmmwzPAlZO
vLSKYRWObJBU7ag95fr4LptxD0nVfzXytesyTYRyyjceeqcPNieg4c46mYxalmU9U
BZ1p+2eM3AVLiW9+J/UmWE1M+oAjKiJ7C2OjNda2ap/eCLQUsvHUNQKLz8uawn9
zVJiD40xcpahlf99YhzGtdkUf4vSSaoG7J2g1y12kto6eWS3SawEnm93qJAVDQFK
I91T7QKqJ305eN9WVuv9+uQBgzHBUfMgbaeGtlycTfasOD5P4y52hp536f7+jS9f
bjyLRnXj2Pzpj+fr5XfkbSMU2tecChJsQoED7EhTeymOg00Ot252dORqQxb47Woy
xRH40jusIM+HWXCMMPRPYsHESSG2+Mu1IM11ZN5ofSEUuswoFaboO/ssZaL/Xf+
5rhPpG09YC+I9ZWYyotIl8HQbf1C6hylXTuWQo8bU2IsuXCNH6GdlMJiUtKhLGk+
+RAhVnCc9A1abcvuAYCDFnnngY/b78DIENgq5cmSnC+1740SV3TdxVIVEmz8oCgrt
2UMbnsxrgmTW6qDLZdF0bda4854AI3SQ0G3UUUTTqk8+/E2HOVXKBsPKPKIMi9md
mlRE/xKUvSb/Rtw2AoYjDEyciwi4jCc+nyv6ACbhW017v9FpcHAb8QRD8BxTo2S9
bB5J72cU1BLec3z6p7iYxn9G9GzyHb0R8kbTcwUnFsP8/LGhN9Lx911/2Y66t/2
7GtZkv6xcttKPN4xDfSdu6Ymvjh/2EjvyvitWTXCMmbVTrkLu4DXeBW3SUYawjxi
8UvT441E6oOK669K33yNnj9q+YtuUWm/vx9oIICcv8njy44W/tLS74wXasF6T9nB
OdZB0NVb1cA5gCgkMyY96lBkTe0h0P5gQjU2cxuEsVc9FhEUsR6j5IGpPJAsmr66
HqUKznyG28I+Khru69SZnyewyvKMSnlCrMSMTsIDn7vfZmB7nDbwhSITm7t3ksfP
/weh7b31c9dq1m6Pi89ZZ1hCCSA/VcjpLT0SwbjvG6s7Z0JX10en7Yxr+09RxghB
sfF5WHHhWxjuVC3uQyRMtF5PN4HGo5FI4tSqfWnK4ScVVEKX1SxKTIRJOkkyZTgn
4jyvnToOV6/ViCIEeub6qd/rU7H6I/01SIO60W+hjgqh09CcHz98fH01CoWK9+0a

B.3.4. S/MIME Encrypted and Signed Over a Simple Message, Wrapped Message With hcp_strong

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Wrapped Message header protection scheme with the hcp_strong Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 7735 bytes
  (decrypts to)
application/pkcs7-mime [smime.p7m] 4712 bytes
  (unwraps to)
message/rfc822 inline 878 bytes
  text/plain 319 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <73a42f8e-8f5a-5c62-b982-82ace766fd32@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:11:02 -0500
```

```
MIWTAYJKoZIhvcNAQcDoIIWPTCCFjkCAQAxggMQMIIBhAIBADBsmFUxDTALBgNV
BAoTBElFVEYxETAPBgNVBAsTCEExBTBTIFdHMTEwLWYDVQQDEyhTYW1wbGUgTEFN
UFMgU1NBIEENlcnRpZmljYXRpb24gQXV0aG9yaXR5AhMPLSW9ETmXSs5CVIeh7j00
Boq0MA0GCSqGSIb3DQEBAQUABIIBAIYa3OenGvm2fxVDHCD1/mOK+G0pkvIp9vgH
9ielXt9FsGcfZkoi6msDh/Td2ZLZXWYP3RCOcqvwu3e0M6IEbbWhFVAdgkfJ4k1a
wlfIpe+ECDsja7I4rP2Fle1lPelgQ0yw+pmG/epN9Ga9FVvfKhDTHm0Zr1lmNjIO
FRuTtU+G6A+hQJrCz+DVh/3ub7P1DBomlG+bL8PICgSzVwigtC0Hh905uZWb8ypd
CE7R4SzQfX6u2/I/9K7FgZ9pSp8zZpi5WvcBuJvSqeLgTL08mm+7AMAYHEld005y
B5GFc9fTTV8ByIleLzvFK4x18EnFeQNVtCpoIuJ+BxAihm3OahwwggGEAgEAMGww
VTENMASGA1UEChMESUVURjERMA8GA1UECXMITEFNUFMgV0cxMTAvBgNVBAMTKFNh
bXBsZSBMQUU1QUYBSU0EgQ2VydGlmaWNhdGlvb1BBdXRob3JpdHkCEzB8R0APhiY6
HGLS64MvlsDXhpQwDQYJKoZIhvcNAQEBBQAEggEAhCWApyit+JqyC6p1+Y2mE0rR
LziSUECZ72cLwSS2GXyl4YE86WTYQPgF5IHUymyTwtnqyJkZB2DUP4jOCqOOuHJQ
cEVy+u007cYIp/K1bZY3mKy5EQkdlo6qpOYJmIs03zoQfzYb/5FxBBIhudMqB5U0
t2kPTnlGfSLo5c4FTnCcZVBezJRyA1Gw/tQeZU2Rfe8xySkKEU00vUkIVI96X1RR
UNPGVgO72/V4w/Yr0oF0ZT36RzdW54hhccASlt7VZoiV8z09xsgS05xvs5dleRzz
DcaFCz+bvtACJsJt/UIf4PP1jar9bL9BYoKzI8ypqzxfsmJSYiQziKpEWoaJSDCC
Ex4GCSqGSIb3DQEHATAdBglghkgBZQMEASIEED3mqLx7mUQlV1YW1LncdmAghLw
+jeehq0xxQt5o5VAsKJcy0+00ggRrelnhO/2cQRsFmJHkOhTtWzY7H6P/0Ayw6iG
KvS1Atb7J+ttV21T4UJEzr9abvMIGwZ2wDNZAHuyWv7hKVuriVh/NLsDDFeJXGJVP
XJ01saqeGsyx4UJmjV3alsjtqeEzcU8Dz0TA5l33v1FNXR+HB44Sejg3zHWLPw+2
MMc7WiNZeIcovrOKR8RAuBER74EawKbsNoAG+itMPIr+itjXD1AJNOADfz2SBi7p
zPMS5ypb70F0xnLwme3MS6QMSkV5Qg2l1DVzDR4vfqgLWkjN/fUOei/90ERrY6Cx
Dwt6xloy+cIi6DmMKBiVnblM1UdWhGsgmaA6LV9ZKm4BFXPxxZ9HJRq8JXgRwBXRO
iH6xjdjkVzyPnB0jeGInCRBz5vPp4GFUhXPulwJzuOjVdvMecqrciyF/sN/RfqGo
KmZ2YO6iKA0aijTPWeDprUeE3BgEQ0DwyjySWTsnAdqPBCT3XPpUV62nhb9Iu5/
P459Trn6R0LapKmeKdTSj6QC+pnDL7dMIynjzirX+EfkFJVSiy/PgsnQlA8vRut
1CtmYTF3GAtBd4K58whmTBLBzyuJlXKNmmZ/OvfalVZ/+Zsz+vNdgvurE+Gev2kO
PGn+OBtx35F7joWW/HVgzhySOztE9/erD/1mAc5Gi+YH5pvlit7QLtow3x4srGHv
TbugWvLVdIkzufB8k7IlDyMGYrAP70BK2ogKd2J4QqDot85YmwPephof+R9SszU2j
```

PyahZrlxwglLbuw8Qhv7pad040Y+Af55ZVktcqV62T4PaYy3Qc+gTOSfcNf7BoR2
aIsaoX+OQVuL7SQo1ltzETE1bliyZj5Z4DUWxyqmrz4fJHKm99YubT6qe4n1CTFs
NrRcris570kqf2EjIs4VHzpN3bsbMG1Qwr5lb1KXT4EjBO7LFeNppze7Az9Vq3aM
ZoLQ5YMG/OFDYOVIQHqjq9zgoRw2X5KaXC8Fzm/hiSqRVNtnQTXtQaVbSWUo3voP
BX+0zL7U9EGyg3/ZwSLHsteGIoDGA59cFYaG75GTFeR6l8r97ETk jxmxsYbMTyRN
8HfSx3kQpm4ODyvWqaXZuWM+uzSQuTMXro84RtndNGUryVsQItzw8cCTzwle jwj4
9MC92mTKgXkc5ShYU+TiKTchBUznGj27hk1Fmss4YC/V2Q2X5TzdFj60lcuyP9QH
zBlykAgx1+wXuyr4Q8iYy2JN4eC+LQitnzH1EANrnQ06quwQPtdt4qyrF1lu7VN5
wF84SvB7KsJa j6ft5FvsPjafdp5z8Yq585ytPwLQ8+os0fJC3GosIznppJPx/13d
+4MV39BoENEB3AJe3UHtafueBqmwzSG1pslgcX/Cnrrkracywi8tfKEVXRaERzKw0
D41TD4R3R1w5duqTfVJ8c8gSDR84UW+XZ8e9aXRPkKQGSvfquuTDZ77ed+0Y5+g
2hse1k2svSQFnkH+OWAcGZy4RarI6CoovVbqaByGnwB3G6R3rztT6g6b9kv+qps
sOnBanfi4yEoYUVw9eo3cqLnjo63eT61aOcl6DqDRo95D5VLZPCBT2xBh9D1KV+b
6kvyLoo8/HJDIQHPnsKwoGaQMXkg15kAx0aDxKp00IFxaUU42cxKMyEmrfzFx7Dj
cXH/++jrgD51788PaAfS1L73WAlQafbExqQe4t i i8gPrjCyVo3/XsIcciz1TJDW2
OOfINjUrCW53bLkxn5xA40FX7zOBGzvwNygBfhnULPDEthU61q4MU25UY/tnFPqK
2GjtgQrOVpFlitYCjxWcFoEFWYCy774wU6juHT4nDuKpCLXuJcnyzRLbmRnQpO81
skocHI5mRHtDYfeyzioG1qGG8wC0c8JX3wrXHX8LSnjkQYf4mPiClzbzWXSAS8Pe+
xwxV7EvU4maXQBIWUshvL85WdfXABKw+cvg/dt0OdCt8yz2vz44qf6Bnt6z5jMJ3
SW7Bc/4FfH5W+uZV8uuXChFs7aWVW/rWAcB6saT5KoOm3EhrxXxdGJeeuOP05xJO
UR8hsj95Icad4yP2mtnh7kKrTXtv7MsRsJKqLWRhaeSDf2XBvluo1V31F/mFYmaZ
gdvAyxbl6rY5dljH2moP4TxjvaA6V331FYCecnv/e5UZQBjLE4WEZYAAuTwgn2p
/B85JP1/yB5BP5pzm4z3M3ye64BKsmjN4xwsFkHuKg5whYiKQ+/BhL2x+Jsu8iY2
7y10AwMhlBFADf5DjFsfueouIj8P3wpPMF3FVsv4hgkQH17zZiNtyaga9q+zSz7Q
omgiUOJMcV3LSXnjkf8GhyqwEuliZDmn1HBMMy90ASC4bTIfHa9bBG5TJzDnNtUiC
FHNcdERJw28fod0FPvZQaQuvN+sLJ0tmaycsOnIkGUjxqu/GYRR2hBPo6QEuwXAG
paGbRSmSLomG65AEk4XKCsTrEQUWvejYnIi9G8J8fu5pLoHZ7HQUBttthmah3S/A
s/yRcqqUz/83XOJuf/OybwGDGRGS4Y03Mnq9H6owu3F2h3BwASjK//nflxm7AvpO
RxskZ/s6dMLJjWA9+g/uacJozJa5d5Ey6yY2TKR8/Tl43/b31aJfj1rfRcXLPBJ/
AJQK60RoDNFmmJKIF66xB6g8wF2pumwve8XW/BK+c7baEInLSnMqHeqpoACrk9BZ
Y+hM+2Pyq8kK2hvw4eG5C14z1JSwrT55SNbSY28iJUEJNE5dAQzgy1f3vg03Key
pTCAyPZ1nZa/1ttJOKiHwdSq5ZdxxRWC5WZKv+9bHdgQqgmEyNgasTaIkdjeriZN
pQMxHCVUBUggzpF90c/GOIx5F2P9f9cRVE5eHACIGn9noZgCrLsJ0VMtRWBy/dCa
3eS1++nDtO//2DHkUHLjdIZ1fcbqE/4BG9z071HZhOP/Lu9thTQOmut1W8s1r1XQ
LYe9hz9oPTVDsVxNF28k8YKuivkBic+9tw12H4pFyBhJyJ8+mhXm/dbkq2ivrRYJ
0tP8vrLftBt5kocdUYzpauQR5K7PAM+pNfo6vpOLN+ODgV903fOYoqk7GmfN0YU
wXC3tPljdjOSQhNCiH6YdMljREzY01Yf4u5hpBimeyS+WauFcNu2Misbo3e+4x3zA
3DyNYJKgj591NEbZA0Nd8pQ22qvBpsKyZTIav91dItntTsORY8XTvXmYj+wYt/0wB
/1/G8jrnXetyASXo0gARxWK02+dpn+1waz4ml98luqyl3fwp6F5X3vimLQTSgIy0
RCgxOzZZBQxX7fFrT+erTGjtoVMMXaLwepMqrB6aGAF611Ku6bQ0c9/RpYK+tegt
R4ZqLYg4Acma3X4mRmX9XZC7WJzYIFuJRQw7/vFPBz3dsrtt/F+j8ggLF+NLM2B
yFZMUYJmrf+jU8PxL4mHI5UxLjKvhZ/LyNG3jbTXT9jQeK3AQ9HCUpXkFhbmrvRm
LQMXiFq4gGwm9PgAweg3fY06TEy1laIjyDNNeIld9vWCiNG/tgH5NoczSUSbOPSw
11WCNMJRiJHAjWGHquAN/seBE3gCFftDU6UgZVAgH0WE3z6nVzAzrmFR/Lwe1kU4
T+WwUYBi0CMzn44ecVwA4n3GL1aWgGcKo+g66jUfTtng2IIn8dm84QtW7RDM4Lku
iofBom42+RzL7IYOiZPqzAccfAOiFb/yOekTLaktqrksv5P8PKNkgGFBFDrMc5br
VTOZVVDiZcvQZ6kvW1Hd0yHfOGSqM/YPchVUGjof4khiq9XXzwFamWw1knjNR/Lx
NwCDMKTzXEbiuGya/NZP6dKazhSCHMmElY12TVgS9+q45eY3J0hHiKnjMrEQP/j/

txu2pgqDedURvXNsT6R+R/MilcsUoRJag3zVxzTaJghdZdsw88WO/0IzTIIzmQwd
v3nDIYOZwVwCL5QnjKgeMDK8Tr5BHBjDdV8QZOpVtki7/EgJ28ddySuaxqtzzYMX
sb1eBNjSIjgx0a3k148jnf6V7PqVy5m/2OPcQmly/3qtl78b8N2cNBzBavyAKnUM
68dCfQ35iCnVUIfIwfnUVhNKiiKAGM1/6GBAN4aUgqdlLq4BBgJMU9aYRObiepXc
YVKXWJOjsKOaHKTWWTjaWi2DEn3h6PkLidZm2ZMm5RJSwX5H5Qj4Sh7NcATBZNnS
bBOgTrBj4ygnhnPWStTQOygKTVZ9beT+GLsJGD9xI6vejro4j/Vw3sYTYuigmCM
ufMS8n8P2IB/DjVU/GE2+dZ5mL33sUbjHIHJ6J6+1XISEI2F6YILoCK4x7gBp0Vr
5BacDYcAwfgbI45ZurXWaxY2i7zHg9mupavujjwv6y9MuLfkHR163xEkFX67ZOz
u4aCFQZ/8u4WiAVcyQKTypzfNxxz117azpUwT7E2IEpPF/zDVpeo7K2W4fHgrG+lp
lNc5f7flrrbrl09/V7dMTmqocFjjjaOmHOvpVv1kpKoscVEoEeSx41nMmyPyJkEDP
INDak1B9tt/t3q+vEQkJKPKojFQ1Yzchs41+z4aJ+4ccU0+3K5tfrungA9LCevnY
+R/RH+TIGxGMW9WwWjqmKIP1hoD8JmUK9tYC0JHwB0KL7hxf13sIqI/BpNGRZlOG
40HdzmxYZW6HQvWQtUYFxD0a20ZtBp2rRxJmHuB2gK+Wd0t2/HXxQe1JjaW0YQaF
nNmee7PTMk1bCBYr4cJzmOCfTtHAdHN1jrzY55BCHntWekYhk5GpzaMttu+4BsW2
lSrupr4xY1zrZkUYGNXLgU0/hmVCasYJSShyppw/y8ZGpFI6uEzHY0gok0akWFL7
7SN0PdxP3abKrRlROInFV5YC1hvjSnESTZZxk2Jv14j5q3d00CWROB/y6+P16954
jSp+il/Fop41IpAt22NZgwC1jMg89aTnK79THy+SSj4S5J/2h7QaS3v9XdGKmJ0J
msVwgavzK2amj4InTp5/dT5nMAA+GgvvF/8+W/NNc3yTSG/D3M5re7p2Jof7Ueo1
Kja5SytmeF5+Ot6fhwQhi17nUZC0dgCXg4ZnKR7T4Cha9WB1YUOtNrGr+Xi2Y7F5
nJ16NC+K2jcyXfO27VTNA3xaOhtwg9pioeYaZmqErIRhm/8R26ganjVK8Zx9AmxK
sn25U99AmTeiMNxwMRFFQC363YrcdX6kz/YV81DvEv9SeJ7psPY1CkTVJ+OUn9T+
PauBE+VH+Df/CAJF2yJyEMr+M+QZiXqxBI5pGC9lDRQvLEzkOKwbs0dlG1Qroafw
KbJh6WiJufkF0nInX8FFCIUKF7f3WoqrbGGXm+rgdGcThmxv1T/vEuPSEhJyzX4
pA52Y6LUOg23VlibFqWZVtZ/SYG7gZ4mT4iYak7bA/g5NGLBi4DCstHKKWRB48OY
bd/v/ix9e1l8Pno0ximW9AI9vHbZqAmCpMjKMumYiSh3UuaxfN3Wv5dU6eUbQOzo
W7yrSBHi4Ik8tbe1XjdKHg0Q90NHbxBMIZY07NC8gTM/VRUNOR0wZkjo9yzmu/xN
CDdNA2mBeFwoa6gkhUOahSLAgfCcHYKN0yv0JHTYULBkfGG7Dvp5N1j5M0oDhJo5
0CP7VXrZUyYDUBGzZWS/JTH+VroILUH6exoyHIJzrwTRGqEZmEcAOv5/r6fGYQdx
UMWRAAuh2/IEDketRdcfnRZLv9jmqJj24wFjcuaigZfLYj8VWvfjnlhZDUDpZOS
aO0SEBBTr7Oi8iryKiT+fvaoo/SMm9fu+Rqatl47jO4FcZYHaDj0GE7KBEQe6FR8
S6jqCH+/IbFDXj/scyQAYE/PxCW2BjsihktnMXqz7D7+8C0JYiQpXw8VegGob60V
R0fYbKp9R55mRpxI9th+PhEhggRqvM7sf1Byaw5K15s/+M43RPzL3hDdlgDRGFz5
jKEYDNArBSzxUCrRfGU8q/OrapWmIjAFdMcH9MSh73X6SmLMTsHjniSCQ1nmbZUQ
uWND/WSArv0cT19TpVRWgPYZwQQFPE88x0DwcIaqz0DFpWgE/4ccx9uyQwfZeSb4
K2cp5yDrYxdTciH30Ha9+w+7/2XK/AfEgSBMtoYIkdN5yNggR7NLhj3cMzaHLhQx
WGDSSxoEctMarW2aXUTpzIvJwAM0z3Z/aF29DnihMhTWC88s+rizq5abnNNTODQ/
1RUfCGKmV48N5Qrtr6UstwDqEFyMqLGnqR3WNTQYZM+4EiAVEVecZyjoayQj7hF8
4vGVhj7am2+BDUVCY4r9wLu9n0VCniC2wOafjm9ET7RmuhoebdVxm5Dzog007bAr
lXhMnax1jhzQkS9T+wygwTBVedEJPb4H0EMA+E38Xjo610XHH/F3Dp1yhW+RD3oU
jwrH8KIx1e+RN0R3zmkr8I5RFaIWWY8lQk6YgJvbsKjgCSPg+/hQ4cL6uLaGxkJT
gkBqMWgKsJFrcQst2zUg46wBjHJF+k1lcfkvp7dMQn/CbmiAZ1kVTGMgHkrzBz46

B.3.5. S/MIME Encrypted and Signed Over a Simple Message, Injected Headers With hcp_strong

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Injected Headers header protection scheme with the hcp_strong Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 7605 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 4630 bytes
    (unwraps to)
    text/plain 331 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <27139e00-e05f-581d-a339-d2bd43bd0f42@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:12:02 -0500
```

```
MIIIV7AYJKoZIhvcNAQcDoIIIV3TCCFdkCAQAxggMQMIIBhAIBADBBSMFUxDTALBgNV
BAoTBELFVEYxETAPBgNVBAsTCExBTVBTIFdHMTEwLWYDVQQDEyhTYW1wbGUgTEFN
UFMgU1NBIENlcnRpZmljYXRpb24gQXV0aG9yaXR5AhMPLSW9ETmXSs5CVIeh7j00
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B.3.6. S/MIME Encrypted and Signed Over a Simple Message, Injected Headers With hcp_strong (+ Legacy Display)

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Injected Headers header protection scheme with the hcp_strong Header Confidentiality Policy with a "Legacy Display" part.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 7845 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 4806 bytes
    (unwraps to)
    text/plain 420 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <fdccb76a-49ed-50c5-9030-e4aeb83d7f04@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:13:02 -0500
```

```
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```

B.3.7. S/MIME Encrypted and Signed Reply Over a Simple Message, Wrapped Message With hcp_minimal

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Wrapped Message header protection scheme with the hcp_minimal Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 7800 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 4770 bytes
    (unwraps to)
    message/rfc822 inline 920 bytes
      text/plain 327 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <smime-enc-signed-wrapped-minimal-reply@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:14:02 -0500
User-Agent: Sample MUA Version 1.0
In-Reply-To: <smime-enc-signed-wrapped-minimal@lhp.example>
References: <smime-enc-signed-wrapped-minimal@lhp.example>
```

```
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```

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B.3.8. S/MIME Encrypted and Signed Reply Over a Simple Message, Injected Headers With hcp_minimal

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Injected Headers header protection scheme with the hcp_minimal Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 7695 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 4692 bytes
    (unwraps to)
    text/plain 339 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID:
  <smime-enc-signed-injected-minimal-reply@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:15:02 -0500
User-Agent: Sample MUA Version 1.0
In-Reply-To: <smime-enc-signed-injected-minimal@lhp.example>
References: <smime-enc-signed-injected-minimal@lhp.example>
```

```
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vME37CehB9IHyjYq7pikz7vLFdRn7JyIbPqExItB861lsXkKvJPsmekJE6kzvJD
KWZrv4qEgfgqOMJHavYX2TQ==

B.3.9. S/MIME Encrypted and Signed Reply Over a Simple Message, Injected Headers With hcp_minimal (+ Legacy Display)

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Injected Headers header protection scheme with the hcp_minimal Header Confidentiality Policy with a "Legacy Display" part.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 7975 bytes
  (decrypts to)
application/pkcs7-mime [smime.p7m] 4898 bytes
  (unwraps to)
text/plain 435 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID:
  <smime-enc-signed-injected-minimal-legacy-reply@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
```

Date: Sat, 20 Feb 2021 10:16:02 -0500

User-Agent: Sample MUA Version 1.0

In-Reply-To:

<smime-enc-signed-injected-minimal-legacy@lhp.example>

References:

<smime-enc-signed-injected-minimal-legacy@lhp.example>

MIIW/AYJKoZIhvcNAQcDoIIW7TCCFukCAQAxggMQMIIBhAIBADBsmFUxDTALBgNV
BAoTBELFVEYxETAPBgNVBAsTCEExBTBTIFdHMTewLwYDVQQDEyhTYWlwBwUGTEFN
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Boq0MA0GCSqGSIb3DQEBAQUABIIBAJDxg4GjNIaOr9Kf4xVYzLZ9okfUMbBaiZn
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VTENMASGA1UEChMESUVURjERMA8GA1UECXMITEFNuFMgV0cxMTAvBgNVBAMTKFNh
bXBsZSBMQUU1QUYBSU0EgQ2VydGlmawNhdGlvbiBBdXRob3JpdHkCEzB8R0APhiY6
HGLS64MvlsDXhpQwDQYJKoZIhvcNAQEBBQAEggEAVQdgmLjOaxQWmpnLHXA3Y2Zk
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E3U4Nx1u3D7tgJ6hyZNhn2mGfZmrHahQ3ZvazhB0pxjIyXo8NmXHioql8I+1loG
WZIZ41ICZl/nR3Wb+2t8WGWOwbbhqn5GJdngzvYcRzna36ug4UV+cdp23qceR33Z
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kKuTNojs5j3uHfCRwyrIUVRGMsJnoUKbbQ9wJ8Jx0xamrXJBQfqp8yi2KLpxeYNi
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f2aznRRq5m7qRACNhlppSv8ByS6OGAbG964j4fbUYtdcXQTKA6OZ6lwBd/2jpRT5
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jjskZbSZP9g+gsa8tDiIxepfiG/c0FG+bfDsVMOhHgtkfylvEiT1v7fAghkZmT7d
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Gg1nlw+PBf9g3EgtwKxV66IvFACArHYzpyPzuzT0ICL6sjVmRFgNTU64Dra4uaaj
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4ScqlsR5315HRzoP4mCkIe7hm7pbYSd9tk+uJJULCu0h0ZiUelbNtnZQiSp/zGqM
MdCfV66rAsqEdiY6iwhMos4tJHbn5xWrugyfjc2jKk=

B.3.10. S/MIME Encrypted and Signed Reply Over a Simple Message, Wrapped Message With hcp_strong

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Wrapped Message header protection scheme with the hcp_strong Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 8020 bytes
  (decrypts to)
application/pkcs7-mime [smime.p7m] 4930 bytes
  (unwraps to)
message/rfc822 inline 1038 bytes
  text/plain 325 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <0e210732-9184-5855-9a95-2a635560d3a6@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:17:02 -0500
```

```
MIIXHAYJKoZIhvcNAQcDoIIXDTCCFwkCAQAxggMQMIIBhAIBADBzMFUxDTALBgNV
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UFMgU1NBIElcnRpb2ZmYXRpb24gQXV0aG9yaXR5AhMPLSW9ETmXSs5CVIeh7j00
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/D24dDevouDo4V6YGvbQ0XylrJ7DeIowrlqAq3t5+NbuZZPgDDQ/NdmLdrQ0lsEi
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HGLS64MvlsDXhpQwDQYJKoZIhvcNAQEBBQAEggEAm/DOeCI+Z5umxSECDJc8oKbW
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6cb8HDEW3TJxhB4BMf/offnCpOgw1E6+wlp0h8vgAZsPW/dFSMQKpjU+p1VabchR
Gu45855mlRhL+m1FR/ihLARYrecR8JcRmFr4dFCXcodVIHDjwGuKtk2yWYRPzHcu
3SwOW4QGCKyB7SiWzffuNjoAmBnZA7qhI2CYuZH823xiDMuZ7cluDYpXokDvq9Kv
MPSKR22uK245maFCYuznTJ9Ytsx0ZD4k9u5R5vuQ/TW6NSEfOpXhBO4BXWR47TCC
E+4GCSqGSIb3DQEHATAcBg1ghkgBZQMEASIEEGTJ4Z+U4xbXftzqmsfU/U6AghPA
p9ayt17k6BlaYmjgIihLk/8MjagX8PWTBf8EyjvtPgSVHQtFagEUSz6qxqD8e+EF
kgYXoxwqQ1jG2SgUkMiD6Cnvo5LTABgkStQe48hUtZGTHiNTzdjy20e20eZSbtr5
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B.3.11. S/MIME Encrypted and Signed Reply Over a Simple Message, Injected Headers With hcp_strong

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Injected Headers header protection scheme with the hcp_strong Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 7930 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 4856 bytes
    (unwraps to)
    text/plain 337 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <0b3ea6dd-0e91-5a91-9bc0-3d553f892983@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:18:02 -0500
```

```
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```

B.3.12. S/MIME Encrypted and Signed Reply Over a Simple Message, Injected Headers With hcp_strong (+ Legacy Display)

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a text/plain message. It uses the Injected Headers header protection scheme with the hcp_strong Header Confidentiality Policy with a "Legacy Display" part.

It has the following structure:

```

application/pkcs7-mime [smime.p7m] 8190 bytes
  (decrypts to)
application/pkcs7-mime [smime.p7m] 5058 bytes
  (unwraps to)
text/plain 432 bytes

```

Its contents are:

```

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <b10dcc75-cf43-5fd7-9e48-f932a9d68fb5@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 10:19:02 -0500

```

```

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```

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```

B.3.13. S/MIME Encrypted and Signed Over a Complex Message, Wrapped Message With hcp_minimal

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Wrapped Message header protection scheme with the hcp_minimal Header Confidentiality Policy.

It has the following structure:

```

application/pkcs7-mime [smime.p7m] 9665 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 6148 bytes
    (unwraps to)
    message/rfc822 inline 1923 bytes
      multipart/mixed 1818 bytes
        multipart/alternative 1132 bytes
          text/plain 375 bytes
          text/html 473 bytes
          image/png inline 232 bytes

```

Its contents are:

```

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID:
  <smime-enc-signed-complex-wrapped-minimal@lhp.example>
From: Alice <alice@smime.example>

```

To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:08:02 -0500
User-Agent: Sample MUA Version 1.0

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```

B.3.14. S/MIME Encrypted and Signed Over a Complex Message, Injected Headers With hcp_minimal

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme with the hcp_minimal Header Confidentiality Policy.

It has the following structure:

```

application/pkcs7-mime [smime.p7m] 9620 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 6114 bytes
    (unwraps to)
    multipart/mixed 1848 bytes
      multipart/alternative 1136 bytes
        text/plain 387 bytes
        text/html 482 bytes
        image/png inline 236 bytes

```

Its contents are:

```

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID:
  <smime-enc-signed-complex-injected-minimal@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:09:02 -0500
User-Agent: Sample MUA Version 1.0

```

```

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```

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B.3.15. S/MIME Encrypted and Signed Over a Complex Message, Injected Headers With hcp_minimal (+ Legacy Display)

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme with the hcp_minimal Header Confidentiality Policy with a "Legacy Display" part.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 10205 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 6548 bytes
    (unwraps to)
    multipart/mixed 2157 bytes
      multipart/alternative 1431 bytes
        text/plain 485 bytes
        text/html 637 bytes
        image/png inline 236 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID:
  <smime-enc-signed-complex-injected-minimal-legacy@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:10:02 -0500
User-Agent: Sample MUA Version 1.0
```

```
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B.3.16. S/MIME Encrypted and Signed Over a Complex Message, Wrapped Message With hcp_strong

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Wrapped Message header protection scheme with the hcp_strong Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 9840 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 6276 bytes
    (unwraps to)
    message/rfc822 inline 2016 bytes
      multipart/mixed 1911 bytes
        multipart/alternative 1128 bytes
          text/plain 373 bytes
          text/html 471 bytes
          image/png inline 232 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <95b9bb39-c028-5ff4-99b1-f179cb5d7585@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:11:02 -0500
```

```
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B.3.17. S/MIME Encrypted and Signed Over a Complex Message, Injected Headers With hcp_strong

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme with the hcp_strong Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 9795 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 6246 bytes
    (unwraps to)
    multipart/mixed 1941 bytes
      multipart/alternative 1132 bytes
        text/plain 385 bytes
        text/html 480 bytes
        image/png inline 236 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <23abef5f-8781-5c95-a46c-61e3a4464d58@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:12:02 -0500
```

```
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B.3.18. S/MIME Encrypted and Signed Over a Complex Message, Injected Headers With hcp_strong (+ Legacy Display)

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme with the hcp_strong Header Confidentiality Policy with a "Legacy Display" part.

It has the following structure:

```

application/pkcs7-mime [smime.p7m] 10380 bytes
  (decrypts to)
application/pkcs7-mime [smime.p7m] 6676 bytes
  (unwraps to)
multipart/mixed 2248 bytes
  multipart/alternative 1425 bytes
    text/plain 482 bytes
    text/html 634 bytes
    image/png inline 236 bytes

```

Its contents are:

```

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <9cfcaae2-9fec-5aca-9a29-c98da35b262d@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:13:02 -0500

```

```

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B.3.19. S/MIME Encrypted and Signed Reply Over a Complex Message,
Wrapped Message With hcp_minimal

This is a encrypted and signed S/MIME message using PKCS#7
envelopedData around signedData. The payload is a multipart/
alternative message with an inline image/png attachment. It uses the
Wrapped Message header protection scheme with the hcp_minimal Header
Confidentiality Policy.

It has the following structure:

```

application/pkcs7-mime [smime.p7m] 9970 bytes
  (decrypts to)
application/pkcs7-mime [smime.p7m] 6366 bytes
  (unwraps to)
message/rfc822 inline 2082 bytes
  multipart/mixed 1977 bytes
    multipart/alternative 1144 bytes
      text/plain 381 bytes
      text/html 479 bytes
      image/png inline 232 bytes

```

Its contents are:

```

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID:
  <smime-enc-signed-complex-wrapped-minimal-reply@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:14:02 -0500
User-Agent: Sample MUA Version 1.0
In-Reply-To:
  <smime-enc-signed-complex-wrapped-minimal@lhp.example>
References:
  <smime-enc-signed-complex-wrapped-minimal@lhp.example>

```

```

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B.3.20. S/MIME Encrypted and Signed Reply Over a Complex Message, Injected Headers With hcp_minimal

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme with the hcp_minimal Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 9925 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 6342 bytes
    (unwraps to)
    multipart/mixed 2009 bytes
      multipart/alternative 1148 bytes
        text/plain 393 bytes
        text/html 488 bytes
        image/png inline 236 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID:
  <smime-enc-signed-complex-injected-minimal-reply@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:15:02 -0500
User-Agent: Sample MUA Version 1.0
In-Reply-To:
  <smime-enc-signed-complex-injected-minimal@lhp.example>
References:
  <smime-enc-signed-complex-injected-minimal@lhp.example>
```

```
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B.3.21. S/MIME Encrypted and Signed Reply Over a Complex Message, Injected Headers With hcp_minimal (+ Legacy Display)

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme with the hcp_minimal Header Confidentiality Policy with a "Legacy Display" part.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 10510 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 6766 bytes
    (unwraps to)
    multipart/mixed 2314 bytes
      multipart/alternative 1435 bytes
        text/plain 487 bytes
        text/html 639 bytes
        image/png inline 236 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID:
  <smime-enc-signed-complex-injected-minimal-lgc-rpl@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:16:02 -0500
User-Agent: Sample MUA Version 1.0
In-Reply-To:
  <smime-enc-signed-complex-injected-minimal-legacy@lhp.example>
References:
  <smime-enc-signed-complex-injected-minimal-legacy@lhp.example>
```

```
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+oFUTNXGfsi9C6/DiWdAB7btCMmXVA0KaFPql1HtUAoP+qxrrqwwL3aa3+rtC/wbX
EqG9W+6U6eMBbPw/li++M1aiAWSq7e2Ny1T7i3wy1V1cpSSFhrn2EX10ISlVmPwn
f9yzUwQ6yk3r5CaOXg+LmqWrebMnqXmYtHICGrzkk6c25sKY424S/d2ggJeCkUp7
MHh12qWj0rUtei+DKx3SjkHXhct20+t5E0zmaGQgGKL5C1HR8ODX/pmRH5qWILUs
F1K8Uf+NP6Vwmf3sYpyWchMKWRm1AdDibSGfh1fMarEh9kpxEXuGdcvqxIXfWfHm
ksitbzmMzHhfXy6UtN6VTp5BfYma3rD9dgAQxmkgmGKhEkKnEu6RLq7MVXwh6Kq
H63fldMdx81Dphv6tcpD57BS2748MbIkGpVGekpwg/HQJb4YY9bPOPTpMKzrZ09w
aWdf5qJ8NK638ZEPOYFxoq7LEAOjL5JrmRmhX9OuxyyIhbR89v1IfnCPnozN0s9D
DRqTLEi63UbiVMfSYTJzO1Di0sFoQfMM14/8vqwh4NQU3blC9GcMf/hOQyezuKvx

```
/UHnm64IeGuF2Q875R340q4T5xF/iQzMb6uBWAHCfVB3kDrETQ/nSGPu9qLWMkeG
RkCBrotadhbkdyytBqM9LaqIWPA2ROdr5W3PU0h6ZLUzh2hGRiF9pQ+wLj7lYmIX
5FXnT3n2KzCEVc6XHpU9c+6PAa2nYfIgcslI8IlyyxJERzDeIBNh7m2ihYHyFQ+1
GGkjF2pWvVIN2hB+KS961UAwm+lvvRN9wxl8YSpJ5T2BKNkg0pucDUYP7KYsiRd4
4TCHEqK0JeF3CzYYt9NvKHCulQMa49LArMcEndoKMS2975EqTpq0aP3TpnS/8lUc
E94iZftUsFKhs0yttvYS/fw2OSp62hmT2JIab230p4jd2wpwP8GA1KHZWwjBjB
F9vrhTYbWntat4k8AeEKj2ZjHJMOGmG3sSx33JcaBwWug69Pg7nEcxdP+GxbGyTZ
fPCC/s5G0gxtUc+Xk/sv6wI7gbd1BYAQnBVs4wUVNMw=
```

B.3.22. S/MIME Encrypted and Signed Reply Over a Complex Message, Wrapped Message With hcp_strong

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Wrapped Message header protection scheme with the hcp_strong Header Confidentiality Policy.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 10185 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 6526 bytes
    (unwraps to)
    message/rfc822 inline 2198 bytes
      multipart/mixed 2093 bytes
        multipart/alternative 1140 bytes
          text/plain 379 bytes
          text/html 477 bytes
          image/png inline 232 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <38a0b7ba-76e0-5351-93e9-f44877e20e6e@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:17:02 -0500
```

```
MIIdXAYJKoZIhvcNAQcDoIIIdTTCCHUkCAQAxggMQMIIBhAIBADBzMFUxDTALBgNV
BAoTBElFVEYxETAPBgNVBAsTCExBTvBTIFdHMTewLwYDVQQDEyhTYWlwbGUgTEFN
UFMgU1NBIElcnRpb2ZlYXRpb24gQXV0aG9yaXR5AhMPLSW9ETmXSs5CVIeh7j00
Boq0MA0GCSqGSIb3DQEBAQUABIIBABOfkRzWpe8+giahAB4aK4FyKBN6535VHclc
4f+nf8otkhBtrdWQfFeOuErPGeHzRvmDmaMtJFf1J24hsbhV4RbQ+mbxJPxoqKT5
qOYSj218aZlRvM4E3Y5Cy8i6iFGDOKBVSc+RHv+UukIOs9MhLC3K/Tmf64MQKYL5
```


KX3OCOmRyZAusQXk/S1O/tdvUFaDwvmtiPBbuVaeTmiBIwMfLlqbkuphykeTSgWm
dCU9uBNjhI0/95BexW7+ifLjVpksBbKiyAdHe6+lcnszoNrZWW5P9vzqoPLLUjR8
DDhmEeW3ud6QUGZ7V8qL6Q6cxBpS1lDvqIp7Srf9ue0RTcmv39gIrhoEszybmhZS
pMIInSaJhuYzYfXJS1rNMVIhms08DVO/6k7pm6QA7pMwAI8rntSEf9Z70Uzr5Wg1
eCSuOxHqL71pU49wNap8r3YYK2PuMUtGEzw+u9HBf+F86NyqDfhmVIEt14Q35jQW
/6gpJy+hibsPLpPi6ne8bnvkdNV3dxFoV0o/rD5aiQeJLs0HvthxsMY7qpnV8LoU
FW+fN154VyGg7znerTYHyO1G7tmsxs/ejYaT0gG1rk2WE+9XAGpkZhapB1LUrCu
Y3fF0CPaNFc5kYOy3oNAambJViYrZw5J2zjaL4wb0FRjE3dmpHU+M1ffRK86ke/S
MGai7HW/uAVZA0QpUxUzxnN/zH1xHNISrgStcFeYcNbcx1eMxoARVges7PPEYVKy
QapYffxV2BKZag4215PkkXmppyWpO+gmCYg2ff/Ilu2PN42BmfTe40pPrWSejuDC
CD3coLRnsgTydRsMIAB2XaApMepwEp6BpPyHU1BYRZBdqj+MuxVG2+MBfLYOS1R
B4V6ZQ+AA1UFu++eOVC5umDr8oCisITepnc62S5eQKp/40ia+JUJD/Sc1WNrGGO4
Dy6/2MC05EgKhQxNB5TmUlq0Bn7/JZ0WI+zTBypsMzcHuiBHKy1CAvB3FU+W6L0m
XEuLZeokayYotg1J1fLOqZSziX2RPFub2x3LEPer/NsXISfmfvaKa/2ZHPKQjmrW
FC7447gHXyrU1SzBH4SHPAoplCZMAhA3N439zGM90brt1Aq6XVeAxkiv1r0Ahd40
BrAD7ScUBGHpPEKp5zY7p4HSe0hEyDIumVmKOKY6Jl6X7Lialpjplus+Va7AEAhTv
HWKDWrlryafb5ixrAxR0fKltFtqp84ywO9gUdf6Mam2nY/BFhktiyfmp4iBXDUD
gAAciNotDXSVMwdA4rbCGDf3Tdx+rJg4ny6mGNY57F1jXK8SdnLpyhb0EEtyr/Ot
75LCcXgBPmPN6y69pRF85ezLeUMINmzmLUQqTVupRfU4rFA2NnEUUnFtbpKp1AY/H
pdKfUp6khZU/fCXRoogGeC2LkIsofCiIJA0hf3FShVH8z2hXhjsNRtx1aLUSFxee
rYEG374iurjwcPkZC6dxzrcSpWHfRwS9nsVLVvXFskazr269OWfWiMDVUtm+XS1p
YefZr/+SRGnRa4Xwj9F7b+CC7bHT+otFr3IAaay+RXVAifjHypRUpBVTpk64mp5H
ux8FF/qhgbLjP1PN16ZB6LXV1/HD7dK7Gkqlsfu2GTmjpQwSFx/SMXbDv1bfiQT5
8tR/nY6ZvL46jp0BTxEgezWwX6+SvFaQc/AgMo1L5JdJiUCX3+QUOKE0hVP2PMaT
GjVuRivkEyWzh6eKk9YJqdmB/oCptKFpdEOzh5yqgtPcmT6JQuJ6pJH7fA65E+i2
k9beHY1hd9pzcQiy5Tw7AcXsRX7SOQrdddg/ZK60kL9b6458jJLLTH1R57t89O69
qGiN18bdrFenh9TiqqbwqTAcMLHIKU8Nc+zs9Wbk0eqeMLMpEU5R4TO8EI6ojrZt
gN0hQw6jWCBa9a+plxiF2ShRYSaACdvUybC4hSfMH2fcG0s05cjchKvJbu8W8k09
tKedeNatpRXT3DJWAgKIhh/oWt0Lu3ulGCJxP1f7ip8E8195wrnDFFfIx/0Plrjj
vJpL7nmF1HoXqVLbTyreDAMLGBMYpXv1HH4ef5vrz10A6r8jqoDwo0pcLQzzZC20
4rLCKSCgIC9+6Cy8cfD1tGkoMLb1BRM+8OF07pUwpt3/B5fnMQ+WshXOcVYbcs26
17zUgFWV4Aga3TpicWqc+EUAhYt7DEbQ3c773y08sRjFiHhacpBrI+7aDFJpbFkj
SpCKzY5ReQxDbZiGcbxic1GGaUNQ/qFX28n/RvgIWGA0z7ytsme2pcEmp+jJLT9D
JJ88hzFliK1qLGCRwj3iVjROpgnAjd/yPpwB8TNyoEc5UrDNOBoRlRX1djWQSkRF
onCJ81DfXJOBNvttb0AABLwvqiA+jewXyRnD22gxx/m+uD/6jHJ+U587W/Yhr2Tg
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yrN1F3Zfynt67Leat25Zy8biHCLaO5ccNMG5SEfzugj1zGosW9w/g22cqZ4k3FUG
uWagQYAZeaP7GZNGR+Mf2/x8YTkq2nUoeHt0Ehk3YQ8NMTgcE53T5Pa5op4sEQVZ
Mr5+LscPIMKOP1Q35uNIkhYMXtZp8/VNuEra3UvMv53Njc3THU/TGjfo+Ye85wss
sGmI68ElTkyDhB2GIdmd/CD68E6Y/u3xhShP9zDqBUh3hHHjJbFF8DYpA9ACBt1
Ad40Vb1lFXoAfY4ZtQ1UaOBgkAkXyQ4yROFNmpWhS3RbRUsez1ie1Sg8PKSLy1YE
bbvvuQGkaYBivNoJHcdFc5ELqdz4F6vXHS1jzMg007leyL6TSFs5nIjvXSA3MsF
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qh5Yt2Ed2/wSN+WnPBBooJPiG35fhI4AiAocKjA9B01Rv85BaVi5UppyviB7YiZNxB
sU7BCMynM1SLqWQgL9HjaBlXzUNzPaU8zkzJVa+/qkah/61CkCp4FL7QNNnbcQgi
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CPzt68j9JSfxpyrGqQpa2c5CP6qJi+eJGfUoLtmc25vt9sYilZTciekJmNDRMMYR
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6Xp60mBNsYuD9ocaffelf2ShqF2KSJ/bkSeYcAIJ72m0l8EXPn+zKu5BDoanCRct
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nhLpYtWLA7cudQFWKBUNazW6YcfZeEzKEXDdEab6CJ5bhZgbXEiw4Qde2snuVkZa
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93ZHIW9LDyeJn9Xc+nuZBzgKxoA5UXA7hkPfOt9BVgIOcaNlUeMtguYf1VjZdKCI
LzXvK5Uz5ZKIUK0WuXmoZHXpCcfFH/3VSpME1LgRXxfWRi4pYyuxFFW0gRPNcizK
MSHIUDYbyzdTPI7Ivp4I2vUTjLVuiQSjYKs4SFc0EKSP3jFxpQX1vDfu0sC2h2pm
kv3Wl5903AEwsj7VXg5zUzLMJ+8Kkv6/dVvevpu8+mIpuBQ6nv6roYU12QWeqPjh
18as6/TS9l9xm3uJanRQN7bxBJ8LBHUJpIuUe9iIj+2Yqv1YQFj0GdKj1Ntn4kSl
KFTg1Q5tewpiCiHnDok48asnI1TDZQrcncQfI/bQmG0BUwZNiJ4v88DYhfQuxek7
hRWqCfQrziFxxInHI1+ABF0Vc1nwZeAiwwanRSgPlUzxMDRIkFWkmpnQC4NoDNay
ECsnUX34Ffh/0hx40cjbPvXpUcQuJpTiN9EIXtJs4lDKbWk3wWe9VfQCjjilkhsh
X3KlX+1PY1/UvqHHfxHPaTPKNtrjYtWnASxLoVdF72olBWGSatd/QDCRy38oVNF1
9oV+WwH6ISalLQJugqrcO2uVyIzsiKwFnFR5zqb5N0MdYSu9hXZ+j7IvL+ixFSMh
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IF/XPAfHFyBpXFV3lBiEOCvEpUc8TGNuI19700bifFTjP8K0lGp8X0Th6uGoj/b
WWZyVRo0a8nx5W2qlabeKQlwaZoJee+HkLeuWqRklVb7kNsJVH6bJiX4zQErsyts
GyzlpsT/kmsldHic1EFAUKvqYPm05t90d+sL9QoB7XxpM0mtsMtgc8n4XXdoCf7w
iSsmnrQqIVPmGBKGUBimxvWyCN6mvWgi8ElgmBwtvdGlsPgAqr0nZrGs4gvd1wul
Aw8mhxEE/brrjPs7o4BVl3Q24eAfr7ANJRQabPapOie4EWeXyUdaljkKsoLauboR
s+CjiB3TdNdRv9zfSBJEocFnQ4MaMvdYXKDvZ6ayeYVkrPCBPlRCMpwHtr3KrBch
luHpRtsLV2SQc16cn/EzQY5Lus6aGyB/KDSF+ONAUhv+BziNvh8ThGFB4L41xIYH
0nNdek9qtNoby1pJ+DAV/CSQRfdRrTMQuTKI+T5WqB8BVvvHCqQBPF8Yyz2Do3K3
2JjAve03MdmMvDDMfDICdYmKt2Lc0p6oE60at1051zb/WUvnGcPKTVuJHlCnTQls
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Dr1kw2XnPHdqRW7F0rvMCYITEP4Rc4DrzMhZTHI5Esp50K2657QkYinOWb07Ki65
fElI7MGkjkfc+ToLDUIz2J9irtdTCSlQDIcgHISCHq7jFVYjdt73ffVhUS2Nsw7
dlL7RXl9TzmeyYTCpkqTsVsz1ncZruj0fU1j6m0RmFQynMmD9lzn8o5+HRBIfoDy
plaipknwoHZjhRYiHqooZo/0DOYHQXA+0vjKQqquJKz9rkDeannMedtBH2Uq0aFW
jPT2PlEVsP59lVXjwWwo2jTjk6F9AOaSB0LW0cwYxJJ08Ev+/NWID0WMEBwmoJ4m
cLxub2XHm2XUdgiXz6EUYReMoMzBSKfehJAZ6rkUxV0i7ZYRLBi+n1RN0XIkTu+o
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dQSi+dw+RqmvtncMqmeBhuEWf/KYbqvTiIRqMrPNnYE0CfRL+y0xS7QVv0Gvr3YL
WMOTTWJZ1wK+JDkrToS5UvoGolPNDzi+md3sYV93BYqbMvzXvzIGF1wq4+h8OWH6
0p7TMxaQK0nHVh36+FW0AZpWApF9NTDBMFXsUiWFENHs8wU13XBgwRBpDuoBqX0m
AgLfBgtXspJq3Qv2qfX7/ltEhG3FP8pJT5iu95AKQD4zm5UaIxqpJLCIOeagV4/
f26RrrdnNKJDPWuT6tke7tD2bKg6d8HJXh7FthEODVu/47P1kS59flwTswKpUP5L
YelgxEG+T+gzcvaOJK5YmqolbH5dCEfF4GhZddT8bGDJ3twRgUHir9mpqVtn3C/7
/ak9jF6gwK1MnJo2QD+OM57TmqhDIzFEvYRn1fiIaMte4As4msonmsSULKG9i+uZ
i5c0Q/1xIoUZ2AZGMGvYlGsAZomj7hxiEkfauxUESHU+Bjrc6JiTzqt40oltN2YP
q5FdnVsdCilp3vMwiH8K+vS570QDlU3Cd4qD9+Kv8UnFyJ5yc5wF8ryIcT+Dz+3G
bRihN7DAjcklJohqpiF/PnDzBQhUWkNc6Du/GE9l1NGv6iEOJbRqeyli8WGMsJBj
p2zTWxHy90xvXqpg9Jci9JDg/ZQOe58RS8hTlu129qRKPkupf+L1c6GZqomxZ4us


```

h63bK4GMIjTOKyZwU5RrDm2Lo5EXizbVfUtKLgaZolxtVdPpbVNXcQNjXEPPjvrZ
HxJUu7gfacXyeJwqj4+9Mkh1FXZ4QEaueqe+ZwrwAX1S+cN5PNNAKcEmYXnjAD7
dDs75K+hx3/LtHe1lbmYPjGOWwyaWfV5Tpz84PSz7FR+tmFbjnalqwLxNBmCGDDp
vClISYOwoWcJrmVxqZqTqWUqOAoggiz0VW1l+RO3z0TYbJLJsAci+AczKYRyzLGC
W4LqUchjKmgzXr0U17ERgR9v6doa0p+ajGrPf1Ys+VJZE5Lb1hMO/E/nrFtjCIGS
AAiD7/MLA5FRO0L72brj37aIXMrrZ9fWZMo5EwzRT+P7hzGMcICyH+1/52it05q5
K0r4TYD3L9oTEpytBI7r3hmf6hr59aez9xbWhHaQYU=

```

B.3.23. S/MIME Encrypted and Signed Reply Over a Complex Message, Injected Headers With hcp_strong

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme with the hcp_strong Header Confidentiality Policy.

It has the following structure:

```

application/pkcs7-mime [smime.p7m] 10140 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 6502 bytes
    (unwraps to)
    multipart/mixed 2125 bytes
      multipart/alternative 1144 bytes
        text/plain 391 bytes
        text/html 486 bytes
        image/png inline 236 bytes

```

Its contents are:

```

Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <c6774fdb-3ef5-5293-ab2d-eca8b66b4bbf@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:18:02 -0500

```

```

MIIdPAYJKoZiHvcNAQcDoIIdLTCCHSkCAQAxggMQMIIBhAIBADBBSMFUxDTALBgNV
BAoTBELFVEYxETAPBgNVBAsTCExBTvBTIFdHMTEwLwYDVQQDEyhTYW1wbGUgTEFN
UFMgU1NBIElncnRpb24gQXV0aG9yaXR5AhMPLSW9ETmXSs5CVIeh7j00
Boq0MA0GCSqGSIb3DQEBAQUABIIBAHw/91uDg1fJb003YLEnXot6ooUedmQUuwrV
0+AAMXpx+Ag22aGkQndo1Enr51SPudU674Rqcmd8GhOYv/SN7k2hJHcVJ1NB1Bqk
KBlndk8OZ3CmHiV04gDZUaH0CvHsXFS/SV2fixL4CuPjl/Ko1O1AFuOU336iRXTe
cxiI6UL/n/feSVf0HNqSFgdnQs1/3pQIOA/33mSJB9gLSZIohefKGYgzhjIO9EU
T3PKk7A59hZhZisoldMUSnuHOMRRRHGbFPK1e9mMe3s/H8LXkqRXFeb9Dvme3R4pC

```

GHEEsT4zJJqOTwYc2o1qn83v22k1Tych2daG/sMgDp+lnYV4KIQwggGEAgEAMGww
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bXBsZSBMQU1QUyBSU0EgQ2VydG1maWNhdGlvb1BBdXR0b3JpdHkCEzB8R0APhiY6
HGLS64MvlsDXhpQwDQYJKoZIhvcNAQEBBQAEggEAPe52qnO+vt6h8MkYH5DP9GdZ
UkyDSFBx4fkz1m1OivGHVrmeMAacHrU0Eithagq/gIoX3VL6+t0czMIm+19svu3a
tXUyCjDjOFS3gXm1wxg91rYWunz1Mj7sMBRt3RjvZXUKhluL1kz3f10J77Y9GoG8
rDj+BnVM4GHuKknTTSaQDYsXnarJOFTLMHFTMefuAf4bSxn/WyNU720tNYG1M0/O
pE+SZPEA+we615WjdMvJwsBZTlhQKxV8mFsAmsiukjWYAWHn5ZaPS0xA8W80NyEh
GF68xjy1tYBwLExtii2NqD+4at16aXj/odar1/FTLCG4fUJeBWH3/ea6keEr9DCC
Gg4GCSqGS1b3DQEHATAAdBg1ghkgBZQMEAAIEEGkoJQ9zwwq8mv0aBdHyfuSKAghng
Z6pgVbu/KHUwPthP3sxFazxNC2ZfrvCGWwUFaxAZQQR5D3WhHqUYWhWoMRP343rZ
NjZzzBNA3KqDRoZ3Oj50M2ekjBb8d477Q2ytFz3wuC6+0jxFO17y9OUBZnlBI2z
HdqO2YJhdm1aLkOrThsXHCdSsr1Jx1sp7fhkA83CcKAI7z3T890f4z8q7pu+AUvG
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B.3.24. S/MIME Encrypted and Signed Reply Over a Complex Message, Injected Headers With hcp_strong (+ Legacy Display)

This is a encrypted and signed S/MIME message using PKCS#7 envelopedData around signedData. The payload is a multipart/alternative message with an inline image/png attachment. It uses the Injected Headers header protection scheme with the hcp_strong Header Confidentiality Policy with a "Legacy Display" part.

It has the following structure:

```
application/pkcs7-mime [smime.p7m] 10790 bytes
  (decrypts to)
  application/pkcs7-mime [smime.p7m] 6968 bytes
    (unwraps to)
    multipart/mixed 2460 bytes
      multipart/alternative 1449 bytes
        text/plain 494 bytes
        text/html 646 bytes
        image/png inline 236 bytes
```

Its contents are:

```
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
Subject: [...]
Message-ID: <aced3c9-111b-5a4f-bd80-34558da32b4d@lhp.example>
From: Alice <alice@smime.example>
To: Bob <bob@smime.example>
Date: Sat, 20 Feb 2021 12:19:02 -0500
```

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Appendix C. Composition Examples

This section offers step-by-step examples of message composition.

C.1. New message composition

A typical MUA composition interface offers the user a place to indicate the message recipients, the subject, and the body. Consider a composition window filled out by the user like so:

Composing New Message

To:

Alice <alice@example.net>

Subject:

Handling the Jones contract

Send

Please review and approve or decline by Thursday, it's critical!

Thanks,
Bob

--
Bob Gonzalez
ACME, Inc.

Figure 1: Example Message Composition Interface

When Bob clicks "Send", his MUA generates values for Message-ID, From, and Date Header Fields, and converts the message body into the appropriate format.

C.1.1. Unprotected message

The resulting message would look something like this if it was sent without cryptographic protections:

```
Date: Wed, 11 Jan 2023 16:08:43 -0500
From: Bob <bob@example.net>
To: Alice <alice@example.net>
Subject: Handling the Jones contract
Message-ID: <20230111T210843Z.1234@lhp.example>
Content-Type: text/plain; charset="us-ascii"
MIME-Version: 1.0
```

Please review and approve or decline by Thursday, it's critical!

Thanks,
Bob

--
Bob Gonzalez
ACME, Inc.

C.1.2. Encrypted with hcp_minimal and Legacy Display

Now consider the message to be generated if it is to be cryptographically signed and encrypted, using HCP `hcp_minimal`, and the legacy variable is set.

For each Header Field, Bob's MUA passes its name and value through `hcp_minimal`. This returns the same value for every Header Field, except that:

`hcp_minimal("Subject", "Handling the Jones contract")` yields "[...]".

C.1.2.1. Cryptographic Payload

The Cryptographic Payload that will be signed and then encrypted is very similar to the unprotected message in Appendix C.1.1. Note the addition of:

- * the `protected-headers="v1"` parameter for the Content-Type
- * the appropriate HP-Obscured header for Subject,
- * the `hp-legacy-display="1"` parameter for the Content-Type
- * the Legacy Display Element (the simple pseudo-header and its trailing newline) in the Main Body Part.

Date: Wed, 11 Jan 2023 16:08:43 -0500
From: Bob <bob@example.net>
To: Alice <alice@example.net>
Subject: Handling the Jones contract
Message-ID: <20230111T210843Z.1234@lhp.example>
Content-Type: text/plain; charset="us-ascii"; hp-legacy-display="1";
protected-headers="v1"
MIME-Version: 1.0
HP-Obscured: Subject: [...]

Subject: Handling the Jones contract

Please review and approve or decline by Thursday, it's critical!

Thanks,
Bob

--

Bob Gonzalez
ACME, Inc.

C.1.2.2. External Header Section

The Cryptographic Payload from Appendix C.1.2.1 is then wrapped in the appropriate Cryptographic Layers. For this example, using S/MIME, it is wrapped in an application/pkcs7-mime; smime-type="signed-data" layer, which is in turn wrapped in a application/pkcs7-mime; smime-type="enveloped-data" layer.

Then an external Header Section is applied to the outer MIME object, which looks like this:

Date: Wed, 11 Jan 2023 16:08:43 -0500
From: Bob <bob@example.net>
To: Alice <alice@example.net>
Subject: [...]
Message-ID: <20230111T210843Z.1234@lhp.example>
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
smime-type="enveloped-data"
MIME-Version: 1.0

Note that the Subject Header Field has been obscured appropriately by hcp_minimal. The output of the CMS enveloping operation is base64-encoded and forms the body of the message.

C.2. Composing a Reply

Next we consider a typical MUA reply interface, where we see Alice replying to Bob's message from Appendix C.1.

When Alice clicks "Reply" to Bob's signed-and-encrypted message with Header Protection, she might see something like this:

| | |
|---|------------------------------|
| Replying to Bob ("Handling the Jones Contract") .---- | |
| To: | Bob <bob@example.net> Send |
| Subject: Re: Handling the Jones contract | |
| On Wed, 11 Jan 2023 16:08:43 -0500, Bob wrote: | |
| > Please review and approve or decline by Thursday, | |
| > it's critical! | |
| > | |
| > Thanks, | |
| > Bob | |
| > | |
| > -- | |
| > Bob Gonzalez | |
| > ACME, Inc. | |
| -- | |
| Alice Jenkins | |
| ACME, Inc. | |

Figure 2: Example Message Reply Interface (unedited)

Note that because Alice's MUA is aware of Header Protection, it knows what the correct Subject header is, even though it was obscured. It also knows to avoid including the Legacy Display Element in the quoted/attributed text that it includes in the draft reply.

Once Alice has edited the reply message, it might look something like this:

| | | |
|---|---------------------------------|------|
| Replying to Bob ("Handling the Jones Contract") | | Send |
| To: | Bob <bob@example.net> | |
| Subject: | Re: Handling the Jones contract | |

On Wed, 11 Jan 2023 16:08:43 -0500, Bob wrote:

> Please review and approve or decline by Thursday,
 > it's critical!

I'll get right on it, Bob!

Regards,
 Alice

--
 Alice Jenkins
 ACME, Inc.

Figure 3: Example Message Reply Interface (edited)

When Alice clicks "Send", the MUA generates values for Message-ID, From, and Date Header Fields, populates the In-Reply-To, and References Header Fields, and also converts the reply body into the appropriate format.

C.2.1. Unprotected message

The resulting message would look something like this if it were to be sent without any cryptographic protections:

Date: Wed, 11 Jan 2023 16:48:22 -0500
From: Alice <alice@example.net>
To: Bob <bob@example.net>
Subject: Re: Handling the Jones contract
Message-ID: <20230111T214822Z.5678@lhp.example>
In-Reply-To: <20230111T210843Z.1234@lhp.example>
References: <20230111T210843Z.1234@lhp.example>
Content-Type: text/plain; charset="us-ascii"
MIME-Version: 1.0

On Wed, 11 Jan 2023 16:08:43 -0500, Bob wrote:

> Please review and approve or decline by Thursday,
> it's critical!

I'll get right on it, Bob!

Regards,
Alice

--
Alice Jenkins
ACME, Inc.

Of course, this would leak not only the contents of Alice's message, but also the contents of Bob's initial message, as well as the Subject Header Field! So Alice's MUA won't do that; it is going to create a signed-and-encrypted message to submit to the network.

C.2.2. Encrypted with hcp_null and Legacy Display

This example assumes that Alice's MUA uses hcp_null, not hcp_minimal. That is, by default, it does not obscure or remove any Header Fields, even when encrypting.

However, it follows the guidance in Section 2.5.8.1, and will make use of the HP-Obscured field in the Cryptographic Payload of Bob's original message (Appendix C.1.2.1) to determine what to obscure.

When crafting the Cryptographic Payload, its baseline HCP (hcp_null) leaves each field untouched. But it also knows that In-Reply-To, References, To, and Subject are all derived from Header Fields in Bob's original message.

For each of these Header Fields, it observes whether the origin Header Field was signed-and-encrypted or merely signed in Bob's original message.

In-Reply-To and References derive from Bob's original message's Message-ID field, which was merely signed. The To Header Field is derived from Bob's original message's From field, which was also merely signed. So these three Header Fields are passed through untouched.

But the Subject Header Field is derived from Bob's original message's Subject field (by prefixing Re: to it), and that Header Field is signed-and-encrypted, which the MUA can tell because the HP-Obscured: Subject entry in the Cryptographic Payload of Bob's message.

So Alice's MUA generates a new external Subject header by applying its derivation rules to the HP-Obscured: Subject value from Bob's message, yielding the value Re: [...].

C.2.2.1. Cryptographic Payload

Consequently, the Cryptographic Payload for Alice's reply looks like this:

```
Date: Wed, 11 Jan 2023 16:48:22 -0500
From: Alice <alice@example.net>
To: Bob <bob@example.net>
Subject: Re: Handling the Jones contract
Message-ID: <20230111T214822Z.5678@lhp.example>
In-Reply-To: <20230111T210843Z.1234@lhp.example>
References: <20230111T210843Z.1234@lhp.example>
Content-Type: text/plain; charset="us-ascii"; hp-legacy-display="1";
  protected-headers="v1"
MIME-Version: 1.0
HP-Obscured: Subject: Re: [...]
```

Subject: Re: Handling the Jones contract

On Wed, 11 Jan 2023 16:08:43 -0500, Bob wrote:

> Please review and approve or decline by Thursday,
> it's critical!

I'll get right on it, Bob!

Regards,
Alice

--

Alice Jenkins
ACME, Inc.

Note the following features:

- * the `protected-header="v1"` parameter to `Content-Type`
- * the appropriate `HP-Obscured` header for `Subject`,
- * the `hp-legacy-display="1"` parameter for the `Content-Type`
- * the Legacy Display Element (the simple pseudo-header and its trailing newline) in the Main Body Part.

C.2.2.2. External Header Section

The Cryptographic Payload from Appendix C.2.2.1 is then wrapped in the appropriate Cryptographic Layers. For this example, using S/MIME, it is wrapped in an `application/pkcs7-mime; smime-type="signed-data"` layer, which is in turn wrapped in a `application/pkcs7-mime; smime-type="enveloped-data"` layer.

Then an external Header Section is applied to the outer MIME object, which looks like this:

```
Date: Wed, 11 Jan 2023 16:48:22 -0500
From: Alice <alice@example.net>
To: Bob <bob@example.net>
Subject: Re: [...]
Message-ID: <20230111T214822Z.5678@lhp.example>
In-Reply-To: <20230111T210843Z.1234@lhp.example>
References: <20230111T210843Z.1234@lhp.example>
Content-Transfer-Encoding: base64
Content-Type: application/pkcs7-mime; name="smime.p7m";
  smime-type="enveloped-data"
MIME-Version: 1.0
```

Note that the Subject Header Field has been obscured appropriately even though `hcp_null` would not have touched it by default. The output of the CMS enveloping operation is base64-encoded and forms the body of the message.

Appendix D. Rendering Examples

This section offers example Cryptographic Payloads (the content within the Cryptographic Envelope) that contain Legacy Display Elements.

D.1. Example text/plain Cryptographic Payload with Legacy Display Elements

Here is a simple one-part Cryptographic Payload (Header Section and body) of a message that includes Legacy Display Elements:

```
Date: Fri, 21 Jan 2022 20:40:48 -0500
From: Alice <alice@example.net>
To: Bob <bob@example.net>
Subject: Dinner plans
Message-ID: <text-plain-legacy-display@lhp.example>
MIME-Version: 1.0
Content-Type: text/plain; charset="us-ascii"; hp-legacy-display="1";
  protected-headers="v1"
```

Subject: Dinner plans

Let's meet at Rama's Roti Shop at 8pm and go to the park from there.

A compatible MUA will recognize the hp-legacy-display="1" parameter and render the body of the message as:

Let's meet at Rama's Roti Shop at 8pm and go to the park from there.

A legacy decryption-capable MUA that is unaware of this mechanism will ignore the hp-legacy-display="1" parameter and instead render the body including the Legacy Display Elements:

Subject: Dinner plans

Let's meet at Rama's Roti Shop at 8pm and go to the park from there.

D.2. Example text/html Cryptographic Payload with Legacy Display Elements

Here is a modern one-part Cryptographic Payload (Header Section and body) of a message that includes Legacy Display Elements:

Date: Fri, 21 Jan 2022 20:40:48 -0500
From: Alice <alice@example.net>
To: Bob <bob@example.net>
Subject: Dinner plans
Message-ID: <text-html-legacy-display@lhp.example>
MIME-Version: 1.0
Content-Type: text/html; charset="us-ascii"; hp-legacy-display="1";
protected-headers="v1"

```
<html><head><title></title></head><body>
<div class="header-protection-legacy-display">
<pre>Subject: Dinner plans</pre>
</div>
<p>
Let's meet at Rama's Roti Shop at 8pm and go to the park
from there.
</p>
</body>
</html>
```

A compatible MUA will recognize the hp-legacy-display="1" parameter and mask out the Legacy Display div, rendering the body of the message as a simple paragraph:

Let's meet at Rama's Roti Shop at 8pm and go to the park
from there.

A legacy decryption-capable MUA that is unaware of this mechanism will ignore the hp-legacy-display="1" parameter and instead render the body including the Legacy Display Elements:

Subject: Dinner plans

Let's meet at Rama's Roti Shop at 8pm and go to the park
from there.

Appendix E. Other Header Protection Schemes

Other Header Protection schemes have been proposed in the past. However, those typically have drawbacks such as sparse implementation, known problems with legacy interoperability (in particular with rendering), lack of clear signalling of sender intent, and/or incomplete cryptographic protections. This section lists such schemes known at the time of the publication of this document out of historical interest.

E.1. Original RFC 8551 Header Protection

S/MIME [RFC8551] (as well as its predecessors [RFC5751] and [RFC3851]) defined a form of cryptographic Header Protection that is similar to the "Wrapped Message" scheme specified in this document. In fact, the scheme originally defined in S/MIME is a subset of the "Wrapped Message" scheme specified in this document. The differences between the original and the updated scheme are outlined in Section 2.2.

E.2. Pretty Easy Privacy (pEp)

The pEp (pretty Easy privacy) [I-D.pep-general] project specifies two different MIME schemes that include Header Protection for Signed-and-Encrypted e-mail messages in [I-D.pep-email]: One scheme -- referred as pEp Email Format 1 (PEF-1) -- is generated towards MUAs not known to be pEp-capable, while the other scheme -- referred as PEF-2 -- is used between MUAs discovered to be compatible with pEp. Signed-only messages are not recommended in pEp.

E.3. "draft-autocrypt" Protected Headers

[I-D.autocrypt-lamps-protected-headers] describes a scheme similar to the "Injected Headers" scheme specified in this document. However, instead of adding Legacy Display Elements to existing MIME parts (cf. Section 2.3.4.1), "draft-autocrypt" injects a new MIME element "Legacy Display Part", thus modifying the MIME structure of the Cryptographic Payload.

Appendix F. Document Changelog

[[RFC Editor: This section is to be removed before publication]]

* draft-ietf-lamps-header-protection-20

- clarify IANA guidance about registration policy and designated expert review
- emphasize that Content-Type parameter hp-legacy-display=1 belongs on all main body parts with a legacy display element
- clean up/normalize pseudocode variable names and text (no algorithm changes)

* draft-ietf-lamps-header-protection-19

- improve text, capitalize defined terms, fix typos

- Clean up from AD review:
 - updates RFC 8551 explicitly
 - add "Legacy Signed Message" and "Ordinary User" explicitly to terms
 - tighten up SHOULDs/MUSTs for conformant MUAs
 - expand references to other relevant Security Considerations
 - drop nudge about non-existent Content-Type Parameters registry
 - clarify IANA notes to align with table columns
 - explicitly request HCP registry
 - add references to other header protections schemes, but move all of them to appendix
- * draft-ietf-lamps-header-protection-18
- only allow US-ASCII as modified output of HCP, adjusted ABNF to match
- * draft-ietf-lamps-header-protection-17
- More edits from WGLC:
 - clean up definition of "Header Field"
 - note leakage of encrypted recipient hints
 - clarify explanation of LDE generation
 - clarify how some obscured headers might not actually be private
- * draft-ietf-lamps-header-protection-16
- correct variable names in message composition algorithms
 - make text more readable
- * draft-ietf-lamps-header-protection-15
- include clarifications, typos, etc from comments received during WGLC

- * draft-ietf-lamps-header-protection-14
 - provide section references for draft-ietf-lamps-e2e-mail-guidance
 - encourage a future IANA named HCP registry if HCP development takes off
- * draft-ietf-lamps-header-protection-13
 - Retitle from "Header Protection for S/MIME" to "Header Protection for Cryptographically Protected E-mail"
- * draft-ietf-lamps-header-protection-12
 - MUST produce HP-Obscured and HP-Removed when generating encrypted messages with non-null HCP
 - Wrapped Message: move from forwarded=no to protected-headers=wrapped
 - Wrapped Message: recommend Content-Disposition: inline
- * draft-ietf-lamps-header-protection-11
 - Remove most of the Bcc text (transferred general discussion to e2e-mail-guidance)
 - Fix bug in algorithm for generating HP-Obscured and HP-Removed
 - More detail about handling Reply messages
 - Considerations around handling risky Legacy Display Elements
 - Narrative descriptions of some worked examples
 - Describe potential leaks to recipients
 - Clarify debugging/troubleshooting UX affordances
- * draft-ietf-lamps-header-protection-10
 - Clarify that HCP doesn't apply to Structural Header Fields
 - Drop out-of-date "Open Issues" section
 - Brief commentary on UI of messages with intermediate/mixed protections

- Deprecation prospects for messages without protected headers
- Describe generating replies to encrypted messages with stronger HCP
- * draft-ietf-lamps-header-protection-09
 - clarify terminology
 - add privacy and security considerations
 - clarify HCP examples and baselines
 - recommend hcp_minimal as default HCP
 - add HP-Obscured and HP-Removed (avoids reasoning about differences between outside and inside the Cryptographic Envelope)
 - regenerated test vectors
- * draft-ietf-lamps-header-protection-08
 - MUST compose injected headers, MAY compose wrapped messages
 - MUST parse both schemes
 - cleanup and restructure document
- * draft-ietf-lamps-header-protection-07
 - move from legacy display MIME part to legacy display elements within main body part
- * draft-ietf-lamps-header-protection-06
 - document observed problems with legacy MUAs
 - avoid duplicated outer Message-IDs in hcp_strong test vectors
- * draft-ietf-lamps-header-protection-05
 - fix multipart/signed wrapped test vectors
- * draft-ietf-lamps-header-protection-04
 - add test vectors

- add "problems with Injected Messages" subsection
- * draft-ietf-lamps-header-protection-03
 - dkg takes over from Bernie as primary author
 - Add Usability section
 - describe two distinct formats "Wrapped Message" and "Injected Headers"
 - Introduce Header Confidentiality Policy model
 - Overhaul message composition guidance
 - Simplify document creation workflow, move public face to gitlab
- * draft-ietf-lamps-header-protection-02
 - editorial changes / improve language
- * draft-ietf-lamps-header-protection-01
 - Add DKG as co-author
 - Partial Rewrite of Abstract and Introduction [HB/AM/DKG]
 - Adding definitions for Cryptographic Layer, Cryptographic Payload, and Cryptographic Envelope (reference to [I-D.ietf-lamps-e2e-mail-guidance]) [DKG]
 - Enhanced MITM Definition to include Machine- / Meddler-in-the-middle [HB]
 - Relaxed definition of Original message, which may not be of type "message/rfc822" [HB]
 - Move "memory hole" option to the Appendix (on request by Chair to only maintain one option in the specification) [HB]
 - Updated Scope of Protection Levels according to WG discussion during IETF-108 [HB]
 - Obfuscation recommendation only for Subject and Message-Id and distinguish between Encrypted and Unencrypted Messages [HB]
 - Removed (commented out) Header Field Flow Figure (it appeared to be confusing as is was) [HB]

- * draft-ietf-lamps-header-protection-00
 - Initial version (text partially taken over from [I-D.ietf-lamps-header-protection-requirements])

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